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LD PLOWED SOILS OF THE LOESS PROVINCE N THE KHUANKHE RIVER BASIN

.N. ROZANOV, V.V. Dokuchayev Soil Institute, Academy of Sciences, USSR

The Chinese People's Republic is known to e one of the few countries having the oldest riculture in the world. According to available rcheological data dry farming (non-irrigated) the loess districts (loess plateau) of the an'su, Shensi and Shansi provinces has been ing on for at least 2, 500 years. Clay vessels ntaining foxtail millet grains (*Setaria italica*), ich go back about 5, 000 years, have been und recently south of the Shensi province (in e district of Sian').

The entire nature of the loess province has dergone a series of extremely profound anges during this very long historic period, ving to a high population density and a strong ricultural utilization of the land over a long riod of time.

The natural vegetation and the animals have en preserved to the present day (to a certain tent) only in isolated mountain localities, ich are almost inaccessible to man. We find most completely cultivated crops in the re- aining area, while the composition of natural una is sharply reduced and subjected to basic anges.

The topography, too, has changed consider- ly. Excessive erosion has caused an extreme ssection of the surface. Ravine and hilly ex- nses of the "bad land" type were formed in the ace of the former plains (plateaus) and undu- ting flatlands. These areas appear as an regular and disorderly combination of sharp- aked elevations ("mao"), narrow ridges and ests ("liam") with different shaped and curved opes and numerous ravines 100 m to 300 m ep.

Basic changes have taken place in hydrology. rosion has caused the formation of a large mber of new streams along the bottoms of a eatly divided network of ravines. As a result e river waters became increasingly muddy and rried off huge amounts of suspension from rent material (loess) and fertile soil layers. us, the Khuankhe River, with a turbidity of 32.3 kg/m^3 annually washes away 1.36 milliards per cubic meter of alluvium, which amounts to 1, 990 metric tons per square kilometer, or 1.3 metric tons from one *mu* (1 mu = 1/15 hectare) of total area. This is a very large loss in soil fertility; this loss is only 5-10 times less than the annual application of fertilizers (manure and loess composts) on cultivated fields.

The character of the climate has, also, undoubtedly, changed. We might suppose that these changes increased the aridity of the climate, based on information received on 1) the large number of forests, 2) the great dissection of the relief, and 3) the local distribution of precipitation which is different than before (before the beginning of agricultural cultivation), etc.

We have, least of all, data on the effect of such long agricultural practices on the soil. If we study the published soil maps (1, 2, 4, 8, 9, 10) it will appear to us that no special changes have taken place, for these maps show the same kind of soils (sierozems, chestnut soils, gray cinnamon-brown soils, etc.), as can be found in the corresponding natural zones of Europe and Asia which have a younger agriculture. But from separate studies, which are mostly unpublished, we do note the strong influence of soil erosion under most varied forms.

The nature of the effect of long agricultural practice on the soils of the loess province has been examined only from recent studies conducted by Chinese soil scientists (under the direction of Professor Chzhu Sian-Mo) and a soil group (under our direction) of the Chinese-Soviet United Detachment of the Central Khuankheyskaya Expedition, Academy of Sciences, Chinese People's Republic. These studies showed that the earlier natural soils are almost non-existent in the present-day soil of the agricultural districts of the loess province. These earlier soils are found only in rare places (along roads and paths on watersheds, on precipices (scarps) of plateaus and on ancient terraces) where for some reason permanent agricultural practices could not be carried on. In the remaining area we find at best the remains of earlier natural soils which are mostly in a buried state. Therefore, we can travel as much as several hundred kilometers without seeing any basic differences among the upper layers of cultivated soils and parent materials — loess. What are the reasons for these peculiarities in the present-day soil of the agricultural districts of the loess province?

The first cause is erosion. Undoubtedly, erosion existed even before agriculture. Contributing to its development were: 1) precipitation, often in the form of a downpour or shower which occurred mostly in the summer, 2) a slight erodibility of the loess deposits and 3) an initial existing dissection in the relief. However, the effect of soil erosion was not important at that time. A rich natural vegetation safely protected the soils from erosion and quickly restored them, whenever the structural profile was changed by erosion. Clear examples of high erosion control by the natural vegetation can be seen even at the present time. On recently steep (30-40°) slopes, the established vegetation not only checks erosion, but even gradually restores the formerly eroded soils almost to the original state.

Since the beginning of agriculture, the erosion processes have begun to be intensified. These processes acquired a catastrophic character when the lands were tilled almost to the limit. The earlier forms of individual agricultural practice could not realize the measures required to control erosion. The entire agricultural system, its one-sided tendency toward grain production and the absence of proper crop rotation systems, contributed to the development of the erosion processes.

Consequently, the liberated peoples of the Chinese People's Republic inherited a heavy burden. It seems that at least 75% of the agriculture area of the loess province has lost its original soil surface as a result of the erosion processes. Lands with flat topography were preserved only in very few places. The remaining areas are now sharply broken localities of an almost mountainous character with deep river valleys and ravines of very steep slopes, in places, appearing as vertical precipices.

From the classifications existing in soil science (3, 5, 6, 7, 9) a large majority of soils in the area under discussion fall into the severely eroded category. The soil group of the Sredne- (Central) Khuankheyskaya expedition, considering local soil peculiarities, used the following soil classification based on the degree of erosion.

1. The slightly eroded natural soils (sierozems, Kheilutu, gray cinnamon-brown soils, etc.) where a part of the upper humus A horiz has been preserved.

2. Moderately eroded natural soils — wher the A horizon has been completely eroded, an the B_1 horizon, or a part thereof, has been preserved.

3. The severely-eroded natural soils — wh the most fertile $A+B_1$ horizons of natural soil have been completely eroded; present-day soil formation is being developed on portions of the B_2 or B_3 horizon.

4. The very severely eroded natural soils - where the humus profile (horizons A+B) has been completely eroded. Thus, it is very difficult and sometimes even absolutely impossible to determine the character of the earlier natural soil (the sierozem, Kheilutu, gray cinnam brown soil, etc.). Present-day soil formation in this instance is being developed on the resi ual B/C horizon or on the parent material, loess, i.e., the C horizon, exposed by erosio

From this classification most of the soils o the agricultural districts of the loess province fall into the severely eroded and very severely eroded category. From all data available, these soils are adapted to lands having surface gradients greater than 3-5-10° which are mos typical and widespread here. More rarely do we encounter the moderately eroded soils, peculiar to areas having 1.5-3° gradients. Even less widespread are the non-eroded and slightly eroded soils, which are found on level sections, plateaus and high river terraces preserved in spots having gradients of less than 1-1.5°.

To calculate the degree of soil erosion is o great importance for production. As studies have shown, the erosion factor retains its importance even under good agricultural techniqu and good fertilization. From Table 1 we see that the crop yield is sharply lowered when the erosion rate of the natural soil increases. Thus, at a very severe erosion stage the productive capacity and yield (peak of harvest) is twice less that of a non-eroded natural soil, despite similar agricultural techniques and a like amount of applied fertilizer. Therefore, determination of the degree of erosion on an earlier natural soil is the first essential condition required for properly evaluating the prese day soil fertility.

A second, no less important, cause of pecu iarity in the soil is the extreme age of agriculture and its special character. If the natural soils (podzolic chernozems, chestnut soils, etc.), continue to be cultivated in countries having a younger agriculture, for example, in the USSR, the new layer with which the earlie natural soils or their residual have been covered by severe erosion, will, with very few

Table 1

Productive capacity of soils with varying degrees of erosion in the agricultural cooperative Maiak No. 2, Lochuan' uezd, Ian'an' okrug

Soil name	Humus percentage in		Yield in Tzin'[a] per mu by peasant evaluation
	Plowed layer	Subplowed layer	
Kheilutu, noneroded	0.98	0.84	185
Kheilutu, slightly eroded	0.96	0.83	145
Kheilutu, moderately eroded	0.90	0.82	135
Kheilutu, severely eroded	0.86	0.63	120
Very severely eroded natural soils	0.80	0.57	85

[a] Tzin' = 0.5 kg, mu = 1/15 hectare

exceptions, be cultivated.

Considering this, the profile of present-day soils in the agricultural districts of the loess province assumes an unusual profile. On top is formed a special "humus-accumulative" horizon of varying thickness. The horizon resembles loess in color and texture, but is darker than loess and lighter than the humus horizons of the natural soils (sierozems, Kheilutu, gray cinnamon-brown soils, etc.). There is always more humus contained in this horizon than in loess, often even more than in the upper layers of natural soils. This enables us to call the horizon humus-accumulative. The soil structure is poorly expressed; at best, it may be called powderish or unstable blocky. Typical is the strong carbonation, usually higher than in the upper horizons of Kheilutu and gray cinnamon-brown soils. Impurities including small pieces of coal, crockery, brick fragments, bones, and other household scraps are an important diagnostic feature of this layer. These impurities are clear evidence of the anthropogenic origin of this layer. Therefore, it has been suggested to refer to this layer by the symbol "$\mathrm{A}\frac{\mathrm{an}}{\mathrm{p}}$". In the layer are formed the plowed sublayers ($\mathrm{A}\frac{\mathrm{an}}{\mathrm{p}}$ and the subplowed $\mathrm{A}\frac{\mathrm{an}}{\mathrm{s-p}}$) followed sometimes by a transitional horizon with a decreased humus content (B^{an}).

The formation process of this humus-accumulative layer is as follows. The original natural fertility of the soils of the loess province was not high. Thus, the need to use fertilizers when these soils are cropped (sierozems, Kheilutu, gray cinnamon-brown soils, etc.), arose in agriculture very soon and steadily increased as utilization continued and erosion was being developed. In the agricultural practices of China a method of applying fertilizers every year to almost every crop had been employed for a long time. The principal fertilizer was compost, consisting of a mixture of half-rotted manure, excrement, and various kinds of household refuse, together with loess, which constituted up to 70%-80% of the total compost. Naturally, the impurities (small pieces of coal, crockery, etc.), mentioned previously, would be found in the soil too. The amount of compost ranged from 1,000 to 2,000 Tzin'/mu (7.5-15 metric tons per ha), in spots being increased to 4,000-8,000 Tzin'/mu. Estimates have shown that when 2,000 Tzin'/mu are applied, the thickness of the plowed layer is increased by 20 cm over a thousand year period of soil utilization, as a result of the use of compost earth fertilizers of the composition specified. These figures are substantiated by factual data, obtained from studies. In many places we find soils having a humus-accumulative layer 30-50 cm and even up to 80 cm in thickness. We can be fully justified in calling such a layer "anthropic", since it has been formed over several thousands of years of agricultural utilization. In this layer are concentrated the principal nutrient contents, utilized, in the first place, by cultivated crops and it is only this layer which is subjected to annual cultivation.

Below the humus-accumulative layer, henceforth referred to as "anthropic", are situated horizons of an earlier natural soil buried beneath the layer, or a parent material subject to a very severe erosion. Studies, however, have shown that the upper horizons of these natural soils, which are presently in a buried

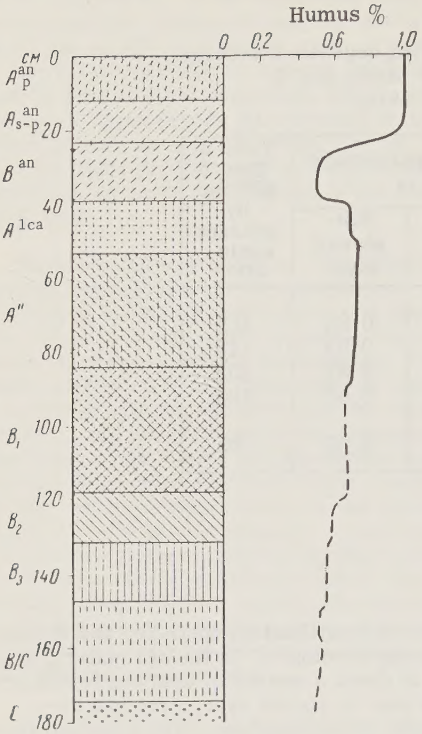

Fig. 1. - Profile structure of old plowed Kheilutu, moderately thick anthropic layer.

Profile No. 103; loess plateau in the district of Lochuan', in Shensi province.

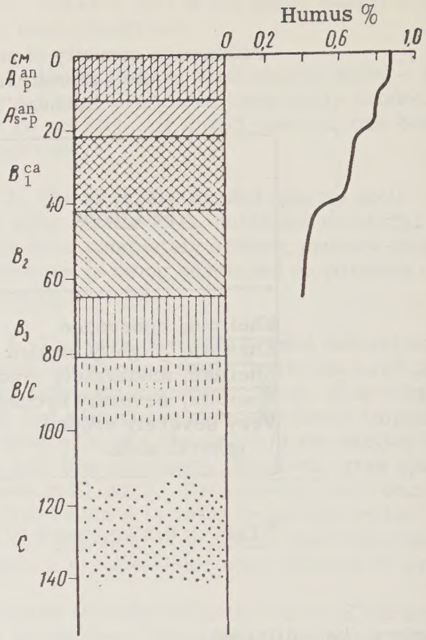

Fig. 2. - Profile structure of old plowed moderately eroded Kheilutu, moderately thick anthropic layer.

Profile No. 328; loess plateau in the district of Lochuan', in Shensi province.

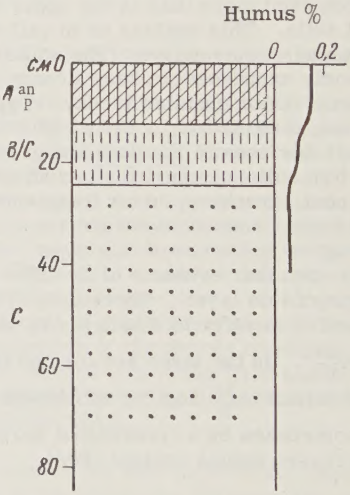

Fig. 3. - Profile structure of old plowed very severely eroded soil, surface anthropic layer.

Profile No. C-7; in the district of the village Gaoseo, Suide uezd, Shensi province.

state, are also subjected to changes. They are of a lighter color, as compared with the earlier soil, and contain impurities of coal and crockery mentioned previously, which indicate that they have been cultivated a long time ago, at a time when the natural soils had begun to be utilized. Therefore, it has been suggested to designate these genetic horizons of earlier soils cultivated in the past, by special symbols: A'^{cu}, A''^{cu}, $B_1{}^{cu}$, B/C^{cu}, C^{cu} (Figs. 1, 2, 3).

In summary, the given data shows that the present-day dry-farming soils, characterized by early farming, have a special type of soil profile structure, which differs from that of cultivated soils of countries possessing a younger agriculture. Based on this, the soils under study may be divided into a special genetic group, under the general name of "old plowed." It seems that this proposed name conveys adequately the character and conditions of origin of these soils.

Thus, in the agricultural districts of the loess province of the Chinese People's Republic, two opposing processes — the destruction or leaching of the natural soils from erosion and the gradual accumulation of a fertile anthropic layer — have been simultaneously developed over a long period of time. Only in comparatively few places, which have not been subjected to erosion, has a one-sided process taken place in the formation of such a layer, with which the earlier natural soils of different origin are being covered.

Therefore, in classifying the old plowed soils, we must first of all consider the character of the earlier natural soils, which have been subjected to agricultural utilization. Thus, the following divisions have been set up within the loess province: the old plowed sierozems, the old plowed Kheilutu, the old plowed gray cinnamon-brown soils. A clearly expressed two-story character of the soil profile is typical of these soils. This is explained by the fact that an almost permanent or slightly changed profile of the earlier sierozem, Kheilutu, or gray cinnamon-brown soil follow the anthropic layer. But, as already pointed out, these old plowed soils are very seldom found as a result of an extensive distribution of erosion.

More developed are the slightly and moderately eroded old plowed sierozems, Kheilutu and gray cinnamon-brown soils, which have retained in their present-day profile the remains of the A and B_1 horizons of soils listed. The old plowed severly eroded sierozems, Kheilutu, and gray cinnamon-brown soils (i.e. having remains of the B_2 and B_3 horizon) and the very severely eroded natural soils, whose features had not been preserved in the present-day soil profile are widespread over the larger part of the dry land farming areas of the loess province.

We mentioned previously the great importance for production of taking into account the extent of erosion of the natural soils, as shown in Table 1. This has to do also with the old plowed soils, because the soils listed in Table 1 are the old plowed Kheilutu having, generally speaking, the same character as far as the anthropic humus-accumulative layer is concerned.

We shall now examine in more detail the properties of this layer, which is one of the leading fertility carriers in the old plowed soils, especially in those subjected to severe erosion and those not having preserved earlier soil remnants in their present-day profile.

The thickness of the anthropic layer is essentially an important indicator of the fertility and genesis of old plowed soils. In the field this thickness is easily determined from the bed depth (depth of occurrence) of the impurities mentioned previously. The thickness of the anthropic layer changes within very broad limits: 10-80 cm and even more. From this characteristic the old plowed soils are subdivided into 1) the surface anthropic phase, 2) the shallow anthropic phase, 3) the moderately thick anthropic phase, and 4) the very thick anthropic phase.

In the surface anthropic old plowed soils the thickness of the anthropic layer is not more than 12-15 cm; i.e. it represents only the plowed layer. In the shallow anthropic soils this layer amounts to 25 cm, by including the subplowed layer. In the moderately thick soils this layer is increased to 50 cm, while in the very thick anthropic soils it extends even deeper and, in places, reaches 80 cm and more.

The thickness of the anthropic layer depends upon the age of utilization amount of applied fertilizers and the degree of erosion. In flat areas the thickness usually amounts to 40-50 cm and more; while on lands characterized by a dissected relief, the thickness of the anthropic layer depends almost entirely upon the surface gradient and, consequently, upon the extent of both past and present-day erosion. This dependence can be seen in Figures 4 and 5, which have been prepared from data obtained from studies in Suide, Lishan' and Dinsi. From these figures we see that the steeper the slopes, the less the thickness of the anthropic layer. When the surface gradient decreases, the thickness is increased, and on more or less sloping areas reaches 50 cm if not more. On concave slopes the thickness of the anthropic layer is always greater than on the straight and convex slopes. As a rule, the lower sections of the concave slopes have a greater depth of anthropic layer than the upper areas where we find, at best, a surface anthropic layer, i.e. it exists only in the plowed layer. These sharp differences in the thickness of the anthropic layer can be satisfactorily explained by the fact that the steep upper slopes do not have conditions conducive to layer accumulation, because of constant erosion. The lower sections of the slopes (especially the

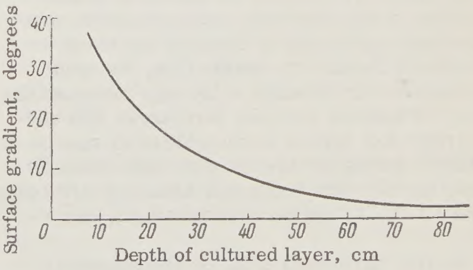

Fig. 4. - Effect of the surface gradient value on depth of the anthropic layer of old plowed soils, from data obtained from studies in key sectors, Lishan' and Suide uezds, Shansi and Shensi provinces.

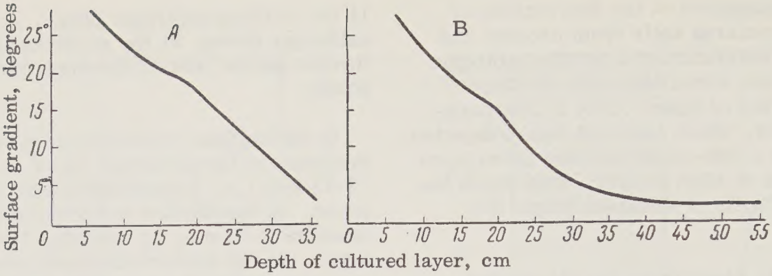

Fig. 5. - Effect of the shape and curve of the slope on depth of the anthropic layer of old plowed soils. Data obtained from studies in a key sector, Dinsi uezd, Gan'su province.

A - steep slope B - concave slope

concave ones), being of a more sloping type, provide an additional increase in the thickness of the anthropic layer from deposition of soil particles from the higher areas.

These data show that we can determine the character and extent of the erosion processes from the thickness of the anthropic layer. As a result, the thickness of the anthropic layer has a two-fold significance. On lands characterized by a flat relief the thickness is an indicator of the age and intensity of agricultural utilization, while in the eroded areas the thickness reflects the degree (rate) of erosion and deposition of the soil. Therefore, the moderately thick anthropic and very thick anthropic layer of old plowed soils are found only on plateaus, flat terraces, concave slope sections and on artificially terraced plots. We can form very thick anthropic layer soils only if we stop the erosion of anthropic layers.

Numerous observations have revealed that the greater the thickness of the anthropic layer, the higher the fertility of old plowed soils. This is particularly true of those soils which have not preserved the earlier natural soils in the soil profile. Therefore, an increase in the thickness of the anthropic layer should be one of the basic agricultural tasks in the loess province of China. To obtain this, we must stop the erosion of surface layers, increase the amount of applied compost fertilizers and use the fertile soil layers as an additional source of fertilizer during earthwork when artificial terraces, small earth walls and Khanziny are being constructed, irrigation networks laid, etc.

As yet, little data exist on the chemical composition of the anthropic layers. A high carbonate, derived chiefly from parent material — loess — which is a fertilizer component, is a common and characteristic property of these layers. The percentage of other matter differs greatly. Thus, for example, the amount of humus in the plowed layers of various old plowed soils ranges from 0.2% - 1.3% and even more, while the amount of available phosphoric acid (P_2O_5), determined by B. P. Machigin's method varies between 2-35 mg/kg. This indicates great differences in the degree of cultivation and fertility of the old plowed soils. As a result, the crop yield changes within very broad limits: from 100 Tszin'/mu of wheat (7.5 centners per ha) to 400 Tszin'/mu (30 centners per ha).

From all available data the very severely eroded surface and shallow anthropic soils of Suide and Lishan' are lowest in humus content and available P_2O_5. The humus percentage in these soils is indicated by such small values as 0.17% - 0.25% in the plowed layer, i.e. only 1.5-2 times more than in the parent material and loess; the thickness of the humus layer only amounts to 20-25 cm. A somewhat larger but still small percentage (to 0.4%) of humus is found in the moderately thick anthropic layer of old plowed soils of these districts (Profile No. L-22 and L-14) with an increased thickness (to 50-70 cm) in the humus profile. Very sma also, is the amount of available phosphoric aci 5-10 mg/kg, seldom more (Table 2).

Better provided are the old plowed very severely eroded and old plowed severely erode sierozems of Dinsi, which by thickness of the anthropic layer, fall into the surface anthropic and shallow anthropic soil categories. The humus percentage in these soils varies betwee 0.6% and 0.8%, while there is, likewise, very little available phosphorus (2.5-7.5 mg/kg). But, we do find in places on the northern slope old plowed very thick anthropic layers of Kheilutu, containing 1.2% - 1.7% of humus in the thick (80-90 cm) anthropic layer and alluvial soil, and 15 mg/kg of P_2O_5. This soil could be placed into the deeply anthropic layer category if the available phosphorus percentage were higher (Table 3).

Most soils of the loess plateau in the

Table 2

Chemical composition of anthropic layers in old plowed soils of Suide and Lishan'

Very severely eroded soils							
Surface anthropic layer, Profile No. C-7				Shallow anthropic layer, Profile No. C-5			
Horizon	Depth, cm	% humus	P_2O_5, mg/kg	Horizon	Depth, cm	% humus	P_2O_5 mg/kg
A_p^{an}	0—10	0.17	10,0	A_p^{an}	0—10	0.25	15.0
B/C	15—20	0.15	5,0	A_{s-p}^{an}	10—19	0.15	5.0
C	25—35	0.13	—	C	55—65	0,10	—
Very severely eroded soils				Severely eroded Kheilutu			
Moderately thick anthropic layer, Profile No. L-22				Shallow anthropic layer, Profile No. L-14			
Horizon	Depth, cm	% humus	P_2O_5 mg/kg	Horizon	Depth, cm	% humus	P_2O_5 mg/kg
A_p^{an}	3—13	0.37	10.0	A_p^{an}	3—13	0.35	10.0
A_{s-p}^{an}	20—30	0.32	5.0	A_{s-p}^{an}	17—27	0.29	5.0
B/C^{cu}	35—45	0.23	5.0	B_3	37—47	0 28	5.0
B/C	65—75	0.23	—	B/C	60—70	0.26	—
C	115—125	0.19	—	C	95—105	0.20	—

Lochuan' district go back to the old plowed Kheilutu with a varying degree of erosion and also to the moderately thick anthropic layer soils. The humus percentage in the plowed layer of anthropic soil is within the limits of about 1%, i.e. somewhat less than found in the A' horizon of natural typical (ordinary) Kheilutu. Even in the very severely eroded soils of this district the percentage of humus amounts to 0.9%. Conditions conducive to the growth of cultivated crops have been considerably improved, owing to the increase in the humus content, and the mean yield on these soils is much higher. Thus, we have placed these soils in an average anthropic layer class. However, the percentage of available phosphorus in these soils was also small (5-20 mg/kg in the plowed layer) and even less in the very severely eroded soils (2.5-15 mg/kg). It is only in the very thick anthropic layer soils of manorial areas that the percentage of available phosphorus reaches more or less normal values (35 mg/kg) for those soils having an average degree of anthropic layer. This stage of anthropic layer was observed also in the old plowed Kheilutu of the Sifen plateau (Table 4).

The old plowed gray cinnamon-brown soils of the Siian', Sian'ian and Ugun districts fall, with few exceptions, into the very thick anthropic layer class. The humus percentage in the plowed layer amounts to 0.8%-1.2%, i.e. approximates values typical of the upper humus horizons of natural gray cinnamon-brown soils in the area. No less than 0.5% humus was observed in the profile of the anthropic layer. The percentage of available phosphoric acid in the plowed layer was somewhat more, amounting to 20-25 mg/kg, except Profile No. U-2, represented on an old deposit. A higher cultivation of these soils is evidenced by a good growth of agricultural crops. The districts of old plowed gray cinnamon-brown soils have the highest productivity in the loess province. (Table 5).

We used the simplest methods for studying the extent of the anthropic layer of the old plowed soils in the field, and watched the growth of the crops. Naturally, this was not enough. Yet, the results of these studies have made it possible for us to present the following theories.

We get the impression of a weak anthropic layer in practically all of the old plowed soils of the loess province of the Chinese People's Republic. The old plowed soils of an average anthropic layer were found only on more or less

Table 3

Chemical composition of anthropic layers in old plowed soils of the Dinsi uezd

Very severely eroded soils				Severely eroded sierozem			
Surface anthropic layer, Profile No. D-632				Surface anthropic layer Profile No. D-22			
Horizon	Depth, cm	% humus	P_2O_5 mg/kg	Horizon	Depth, cm	% humus	P_2O_5 mg/kg
A_p^{an}	0—10	0.58	2.5	A_p^{an}	0—10	0.60	2.5
B/C	10—20	0.39	2.5	A_{s-p}^{an}	12—18	0.63	2.5
"	30—40	0.41	2.5	B_3	32—42	0.26	2.5
				B/C	55—65	0.21	
Severely eroded light sierozem				Kheilutu			
Shallow anthropic layer, Profile No. D-3				Deeply anthropic and alluvial layer, Profile No. D-4			
Horizon	Depth, cm	% humus	P_2O_5 mg/kg	Horizon	Depth, cm	% humus	P_2O_5 mg/kg
A_p^{an}	0—7	0.85	5.0	A_p^{an}	0—15	1.19	15.0
A_{s-p}^{an}	7—18	0.90	7.5	A_{s-p}^{an}	25—35	1.32	5.0
B_1B_2	22—32	0.64		A^{an}	50—60	1.40	5.0
B_2	42—52	0.44	2.5	and alluvial	75—85	1.72	5.0
B/C	145—155	0.37	5.0	A'^{cu}	90—100	2.05	5.0
				A″	110—120	2.39	5.0

flat plains and on artificially well-terraced slopes. We have at present no conclusive data on the existence of a well developed anthropic layer of old plowed soils in the dry-land agriculture. But we repeatedly found well developed layers of soils in the irrigated agriculture.

The predominance of old plowed soils having a shallow anthropic layer is the result of 1) a continuous erosion, 2) an intensive use of lands for only one type of cultivation (mostly grain), 3) insufficient fertilizers, and 4) several deficiencies in agricultural techniques (shallow plowland, etc.).

The elimination of these sources would undoubtedly lead to an increase in the degree of the anthropic layer of the old plowed soils and, consequently, to an increase in the crop yields. The hitherto existing methods for anthropic soils were inadequate. National economy interests of the Chinese People's Republic dictated decisive improvements aimed at increasing productivity. Much attention has been devoted in the past few years to the problems of controlling erosion. As we can see from what has been said, the measures needed will undoubtedly contribute to increased yield of the anthropic layer of old plowed soils. But along with these measures we should see to it that other cultivation methods almost non-existent in Chinese agricultural practices are widely applied.

The principal method is the introduction into the crop rotation system of legumes (Medicago sativa, Onobrychis, Mililotus), for these contribute to enriching the soils with organic matter — nitrogen, and improve soil structure. Furthermore, the introduction into crop rotation of these legumes will aid in the development of livestock production and, consequently, make possible a considerable increase in the amount of fertilizers applied.

Of great importance is the deepening of the plowed layer, whose thickness in most districts is not more than 12-15 cm. From such a shallow thickness in the plowed layer the crops do not find conditions conducive to growth, for at shallow depths they encounter compacted subplowed layers, often with a sharply reduced percentage of humus. A gradual deepening of

Table 4

Chemical composition of anthropic layers in old plowed Kheilutu of the Sifen and Lochuan' Uyezds

Slightly eroded, shallow anthropic layer, Sifen plateau, Profile No. 21				Non-eroded, moderately thick anthropic layer, Lochuan' plateau, Profile No. 103			
Horizon	Depth, cm	% humus	P_2O_5, mg/kg	Horizon	Depth, cm	% humus	P_2O_5, mg/kg
A^{an}_{p}	5—15	1,01	10,0	A^{an}_{p}	1—12	0,92	5.0
A^{an}_{s-p}	20—30	not determined		A^{an}_{s-p}	12—22	0,92	5.0
A'	30—40	1,01	5.0	B^{an}	23—28	0,52	5.0
A''	60—70	0,93	10.0	A'^{cu}	38—53	0,72	5.0
B_1	85—95	0,71	—	A''	53—84	0,76	15.0
B_2	115—125	0,53	—				
B_3	140—150	0,33	—	B_3	170—175	0,51	15.0
C	170—180	0,15	—	B/C	170—180		

Moderately eroded, moderately thick anthropic layer, Lochuan' plateau, Profile No. 328				Very severely eroded, moderately thick anthropic layer, Lochuan' plateau, Profile No. 163			
Horizon	Depth, cm	% humus	P_2O_5, mg/kg	Horizon	Depth, cm	% humus	P_2O_5, mg/kg
A^{an}_{p}	2—10	0,83	20.0	A^{an}_{p}	5—15	0,95	5.0
A^{an}_{s-p}	14—20	0,69	5.0	A^{an}_{s-p}	17—25	0,60	5.0
B^{cu}_{1}	25—35	0,63	—	$BC,^{cu}$	29—37	0,59	5.0
B_2	45—55	0,41	5.0				

Table 5

Chemical composition of anthropic layers in old plowed gray cinnamon-brown soils of Sian'ian and Ugun

Slightly eroded, moderately thick anthropic layer, Profile No. 14				Slightly eroded, deeply anthropic layer, Profile No. U-2 (deposit)				Non-eroded, deeply anthropic layer, Profile No. U-7			
Horizon	Depth, cm	% humus	P_2O_5, mg/kg	Horizon	Depth, cm	% humus	P_2O_5, mg/kg	Horizon	Depth, cm	% humus	P_2O_5, mg/kg
A^{an}_{p}	0—8	0,92	25.0	A^{an}_{p}	0—10	0.83	5.0	A^{an}_{p}	0—10	1.17	20.0
A^{an}_{s-p}	11—21	0,79	4.0	A^{an}_{s-p}	12—22	0.64	2.5	A^{an}_{s-p}	15—25	0.91	2.5
A'^{cu}	40—50	0.65	—	B^{an}	30—40	0.55	3.7	B^{an}	30—40	0.80	10.0
A''	55—65	0.74	2.0	A'^{cu}	48—58	0.72	12.5	A'^{cu}	60—70	0.71	traces
B_1	82—92	0 58	—	A''	62—72	0.82	12.5	A'	75—85	0.82	"
B_2	120—130	0.50	—	B_1	92—102	0,63	5.0	A''	95—105	0.74	5.0
B_3	150—160	0.28	—	B_2	118—128	0,51	5.0	B_1	115—125	0.62	2.5
								B_1	130—140	0.59	5.0

the plowed layer enables us to equalize the percentage of humus and of other nutrients, to improve structure, and to raise the cultivation level of the layer.

Using the upper humus horizons of the earlier natural soils buried under an anthropic layer has great prospects. As we can see from analyses, these horizons contain large amounts of humus matter and in places, even available phosphorus. Therefore, partially bringing them to the surface would contribute considerably to an increase in the degree of the anthropic layer of the old plowed soils. This can be done in several ways: for example, using these humus horizons during cropping as an extra source of fertilizer. Applying deep plowing will better enable crops to utilize nutrients found in these humus horizons. A more effective measure would be a one-stage tillage (for land development and improvement purposes) of these soils by special (deep-plowing) machines to the depth of the buried humus horizons, which changes within the limits of 30-50 cm and more. Green manure which, at present, is seldom being used in China, plays an important role in increasing soil cultivation.

In summary, our studies over a two-year period have shown that there are many unutilized possibilities for increasing the crop yields of peasants' fields in the loess province. Basically, these lead to attaining three goals: 1) stopping erosion, 2) increasing layer thickness and 3) increasing the degree of the anthropic layer. Emphasis should be placed on the fact that only by systematic and persistent work in these three directions can we achieve the desired results.

Conclusions

1. As a result of a very long agricultural utilization, the soil of the loess province of the Chinese People's Republic has undergone very great changes. The natural soils (sierozems, Kheilutu, gray cinnamon-brown soils, etc.), are very rarely encountered because of the very highly developed erosion processes.

2. Together with this most intensive erosion phenomenon there has taken place the formation of a special humus-accumulative horizon above the natural soil or above the residual soil during uncontrolled erosion. The formation of this horizon is the result of a systematic application over several thousands of years of compost fertilizers, i.e. the formation is based upon an anthropogenic origin.

3. These peculiar characteristics in the soil profile enable us to form a special genetic group of soils found in the old agricultural districts to be called "old plowed" and considered as subgroups of natural soils.

4. The old plowed soils are distinguished by erosion, thickness of the humus-accumulative horizon and by the degree of the anthropic layer.

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SEVERAL CHARACTERISTICS OF THE SOIL FORMING PROCESS AND OF THE SOIL IN LITHUANIAN SSR[1]

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This article presents several results from studying data obtained in Lithuanian SSR during the preparation of large-scale soil maps.[2]

In order that these data, besides being purely practical, should also be of scientific value, a complete set of soil profiles has been laid out, in addition to the usual points of study for each 1,000-1,500 hectares on typical soils or on soils presenting the greatest interest. We have taken soil samples, which have been subjected to more thorough agricultural-chemical analysis, from the basic genetic soil horizons of these profiles. The analyses were done in one laboratory, using the same methods; this enabled us to make generalizations of the data not only for production purposes but also for establishing certain general patterns in soil formations.

We selected data from plowed soils under flat watershed area conditions developed on the same parent material. We sampled about 2,000 soil profiles in the Republic. We did not include the eroded soils which have no upper genetic horizons. To simplify the analysis of the maerial its classification, and, in certain instances, the mean indices derived, a special card index was prepared to hold all of the information received.

Three large orographic elements can be distinguished in Lithuanian SSR: in the western part of the Zhemaytiyskaya uplands; in the cenral part of the Central Lithuanian lowlands extending from the northeast to the southwest; the Baltic ridge running across the entire southeast section of the Republic.

The surface of the Republic is covered with glacial alluvial deposits. There is a basis for assuming that the southeast part was freed of the glacier much earlier than the others. The soil-forming parent material, as a rule, is rich in carbonates. The sands of aeolian and, partly, of water origin are an exception.

Based on an analysis of the material received we can cast some light on the following problems:

1. The degree of leaching and podzolization of soils in various districts of the Republic. We can roughly determine this by the depth of the carbonate layer as was suggested by V. G. Ruokis in his time. We determined the degree of development of these processes from the eluvial moisture soils, i.e. from the automorphic sod-podzolic and sod-carbonate soils, which lie on the positive elements of the relief. The soil-forming parent material has a great effect on these processes. Thus, the leaching processes in the different districts of the Republic were compared on similar soil-forming parent material.

For production purposes we were confined to classifying the soil-forming parent material by its texture. All soils to be analyzed were divided into three groups, those formed on a) fine-textured parent materials (of more than 50% physical clay), b) medium-textured parent materials (50%-20% physical clay), and c) coarse-textured parent materials (less than 20% physical clay).

All material was obtained for soils formed on clay loam deposits in our Republic. In plotting the depths to the carbonate layer on the map, we noted a specific pattern (Fig. 1). The map shows that the greatest depth to carbonate is in the western and, partly, in the southeast sections of the Republic, while the shallowest depth is in the central section, especially in the

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[1] Presented at the First Session of Soil Scientists, May 1958.

[2] The scientific methodical bases for these investigaions were worked out by the former Institute of Agriculture and Soil Science, Academy of Sciences, Lithuanian SSR, in close collaboration with the V.V. Dokuchayev Soil Institute, Academy of Sciences, USSR. Thanks are expressed to the Ministry of Agriculture of Lithuanian SSR for use of the manuscript data.

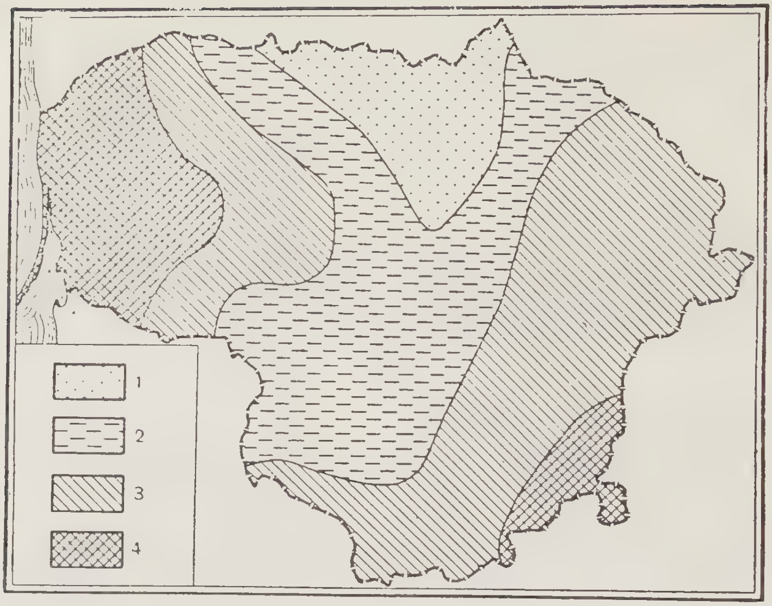

Fig. 1. - Prevailing effervescence depth of carbonates in the plowed soils on clay loam forming parent material in Lithuanian SSR, under zonal conditions.

1 - To 60 cm; 2 - 60-100 cm; 3 - 100-150 cm; 4 - 150 cm and greater.

northern half. Depths in the other districts of the Republic fall in between these two. If we consider the climatic conditions, especially, the amount of precipitation (about 700-800 mm in the western part and 550-600 mm in the northern part of the Central Lithuanian lowlands), we see a certain interrelation between the leaching processes and the climatic conditions.

It is clear that other factors also influence the intensity of these processes — a higher percentage of carbonates in the soil-forming parent material of the Central Lithuanian lowlands, large growth (and in this connection a more prolonged soil-forming process in the extreme southeast section of the Republic) and a long-time predominant diverse vegetation (forests).

2. The acidity of the plowed layer of the soils (the pH value of the salt extract) is closely associated with the podzolization processes. We drew our generalizations using the same method that was used to explain the depth to the carbonate layer. The results are shown in Figure 2.

The soils of the Republic can be divided into three parts according to acidity. The most acidic soils are concentrated in the southwest section of the Zhemaytiyskaya uplands in the districts of Plunge, Retavas, and Shilale. Here the carbonates are deposited particularly deep, with the highest amount of occurring precipitation. Influence and degree of cultivation on ac soil are shown to occur, which can be partly explained by a decrease in acidity in the southwest section of the Republic where agricultural production is higher.

3. In Figure 3 we see the percentage of humus in the same soils (analyses were made with the Tyurin method). From this map the soils have been divided into four groups accord ing to the percentage of humus.

The map may cause some speculation. Usually, with all other conditions being equal, the percentage of humus in the normal moist soils is considered to be an indicator of their natural fertility. The soil of the Lithuanian SSR, as a whole, is characterized by a comparatively small amount of humus. Thus it is associated with a rapid biological decompositi cycle of organic matter, which contributes to the enrichment of the soil by available plant nutrient elements, and increases soil productivity. Consequently, under these given conditions, a small humus content in the soil does not as yet serve as an indicator of the soil's low fertility. It seems to us that the humus content, in itself, without considering its qualit and other soil properties, is not a valuable ind cator of the site quality.

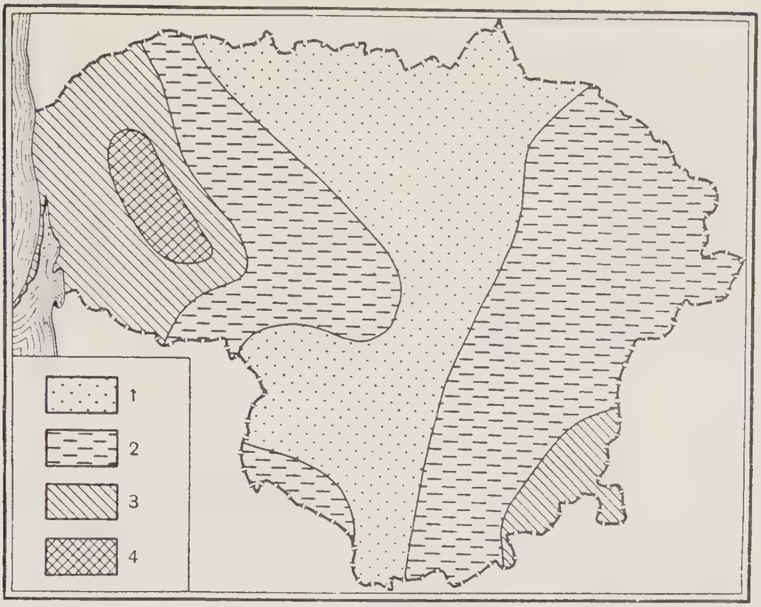

Fig. 2. - Prevailing acidity of the plowed layer (the pH value of the salt extract) of plowed soils under zonal conditions on clay loam soil-forming parent material in Lithuanian SSR.

1 - pH 6.0 and higher; 2 - pH 6.0-5.0; 3 - pH 5.0-4.5; 4 - pH 4.5 and less.

As we know, the most fertile soils in our Republic are in the Central Lithuanian lowlands where we also find the sod-carbonate soils. It would seem logical to find here soils with the highest humus saturation. But factual data gives us a somewhat different picture: the highest humus indicators are peculiar to the western section of the Republic. We can explain this phenomenon by the influence of sea climate, by a high leaching of carbonates, by an increased acidity, all of which contribute to the slowing down of the mineralization process of organic matter in the soil, and, consequently, to an increase in the humus percentage in the soil. We may assume that the quality of this humus is inferior to the quality of humus in the soils of the Central Lithuanian lowlands.

The soils of the southeast section of the Zhemaytiyskaya uplands are distinguished by a lower percentage of organic matter. This phenomenon can be explained by the more favorable hydrothermic conditions for the decomposition of organic matter. In this way, the length of the decomposition cycle of organic matter differs in the comparatively small area of our Republic.

The presence of a clear conformity of the soil properties to their general geographic conditions is another conclusion which we can draw from the maps. Here are two possible cases: 1) the soil is slightly cultivated, 2) there is an unequal cultivation of the soils under different geographic conditions, which requires the use of different methods.

We have also prepared similar maps for soils which have been formed on fine- and coarse-texture soil-forming parent material, based on a comparatively small quantity of data, but which bears out our position.

We should consider as a characteristic feature of the soil of our Republic the comparatively, often detected signs of gleying in the zonal sod-podzolic soils (especially in the western section) which are not associated with the effect of ground waters but are related to abundant atmospheric moisture. This bears out the expediency of distinguishing soil provinces.

We do not see any distribution pattern of indicators for available forms of phosphorus (the Kirsanov method) and of potassium (the Peive method) in the soil of the Republic.

The data available permits us to distinguish more accurately now, than in 1949, three soil okrugs and 12 soil districts in the soil of Lithuanian SSR.

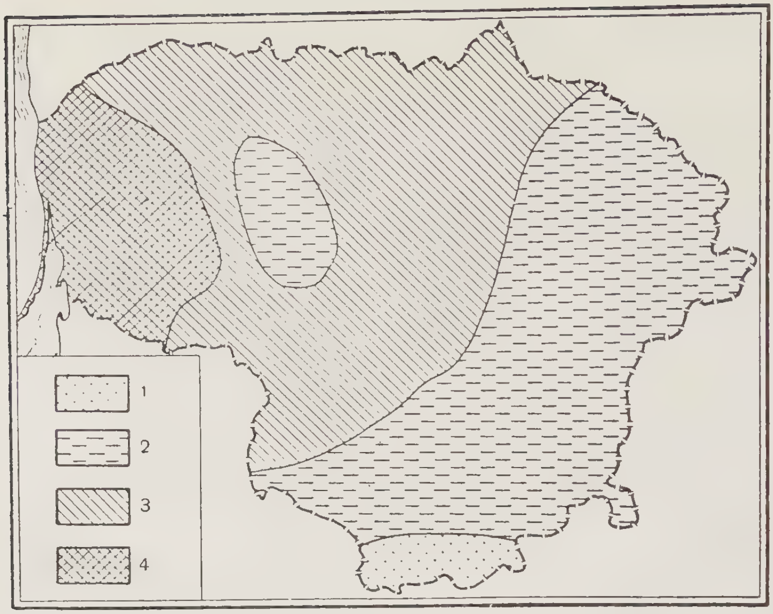

Fig. 3. - Prevailing humus content in the plowed layer (after Tyurin) of plowed soils under zonal conditions on clay loam deposits in Lithuanian SSR.

1 - 1.5% and less; 2 - 1.5%-2.0%; 3 - 2.0%-2.5%; 4 - 2.5% and greater.

These data enable us also to draw several practical conclusions (for example, depth of the carbonates in the soil is one of the fertility indicators) and facilitates development of proper agricultural techniques for the separate districts and makes easier the solution of problems associated with the selection and choice of suitable crops.

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\ NEW SOIL MAP OF POLAND ON A SCALE OF 1:1,000,000

. S. DOBZHANSKI and A. MUSEROVICH

Slavomir Miklashevskiy presented the first oil map of Poland on a scale of 1:1, 000, 000 t the International Congress of Soil Science ı Rome in 1924. Miklashevskiy prepared this ap based on his own studies. From this map e prepared a 1:1, 500,000 scale soil map of oland, which was published in 1927.

Following the Second World War a group of olish soil scientists drew up a soil map for e new boundaries of Poland. This map edited Dr. Prof. Ian Tomashevskiy was published on scale of 1:1,000,000 in 1950.

The Academician A. Muserovich drew up a 1,000,000 scale new soil map of Poland ased on data compiled by a group of Polish oil scientists[1] on a scale of 1:300,000. This ap was based on a genetic classification, onsidering the most important soil features nd properties (parent material, texture, geo-orphology, etc.). The following soils are een on this map:

A. MOUNTAIN DISTRICT SOILS

Soils in the initial stage of development without a profile differentiation

1. Soils formed on magmatic and meta-orphic rocks (except marble): rocky soils d skeletal soils of various texture.

2. Soils formed on sedimentary massive cks, except carbonate rocks: rocky soils d skeletal soils of various texture.

Rendzinas

3. Rendzinas formed on sedimentary carbonate massive rocks (limestone, marl, dolomite) of various geological formations and on other massive sedimentary rocks containing calcium carbonate and magnesium (for example, the sandy loams) of various texture.

Complex[2] of Burozem and Podzolic Soils

4. Soils formed on magmatic and metamorphic rocks (except marble).

5. Soils formed on sedimentary massive rocks: sandy and sandy loam,[3] silt,[4] clay loam and clay,[5] clay.[6]

6. Soils formed on sedimentary clastic noncemeted rocks: sandy and sandy loam, silt (formed from loess, loess-like and silt deposits of aqueous origin), clay loam and clay silt soils.

Black Soils

7. Black soils formed from various rocks.

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[1] Dobzhanski, Kshyshovski, Kurylovich, Kvinik-dze, Muserovich, Pishchik, Skavina, Stemski, ggla, Terlikovski, Tomashevski, and their co-orkers.

[2] Apparently, this corresponds to our concept of "combination." Editor's note.

[3] Containing up to 20% particles <0.02 mm in diameter in the upper sandy and sandy loam horizons.

[4] Containing >40% silt (0.01-0.02 mm in diameter) particles in the upper horizons.

[5] Containing >20% particles <0.02 mm in diameter in the upper horizons.

[6] Containing >50% particles <0.02 mm in diameter and silt particles (0.1-0.02 mm in diameter) in the upper horizons.

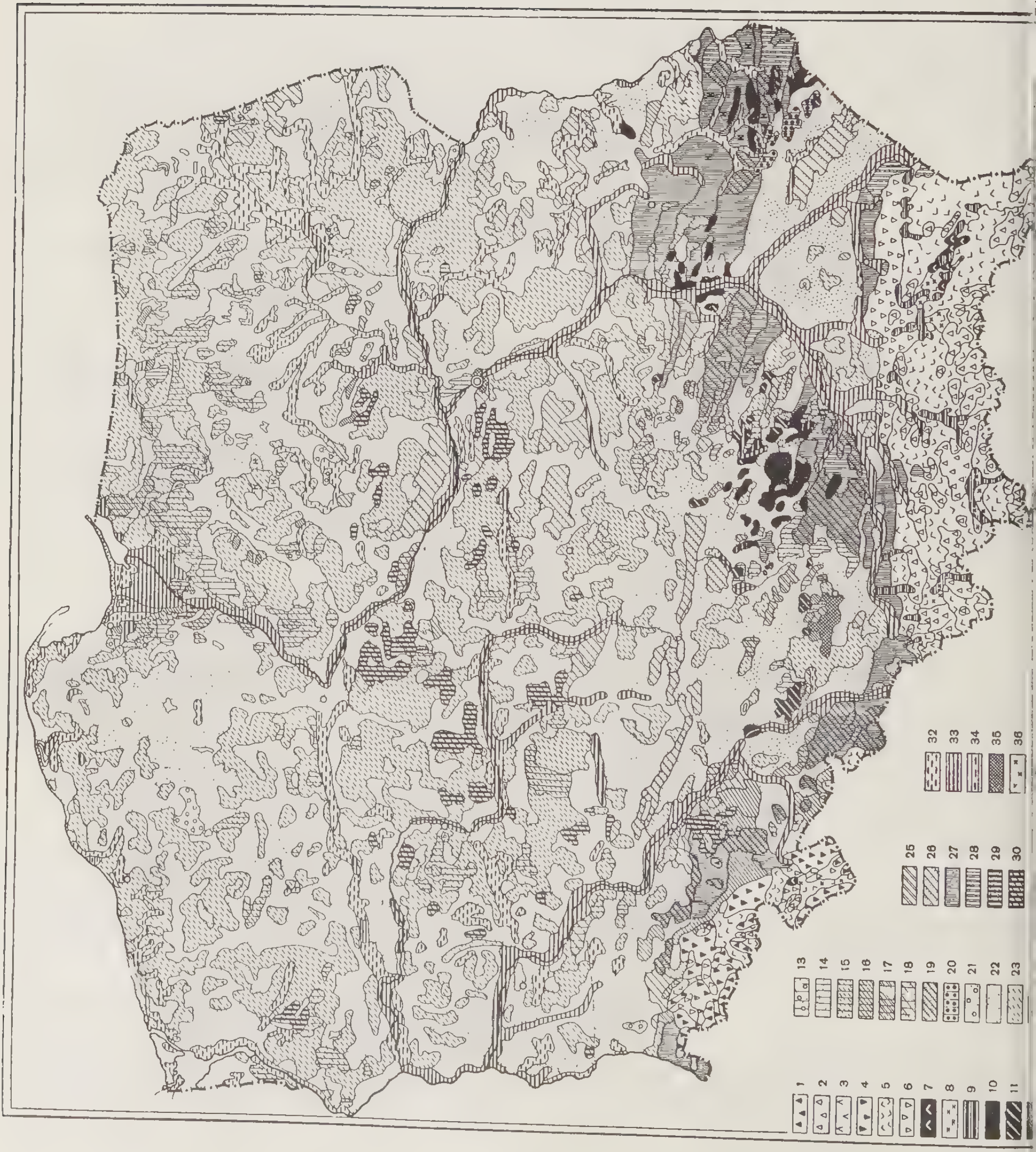

Fig. 1. - Soil map of Poland on a scale 1:1,000,000

Bog Soils

8. Peat soils.

Mad Soils

9. River mads.[7]

B. SOILS OF THE PLAINS

Rendzinas

10. Cretaceous rendzinas.

11. Rendzinas formed on carbonate rocks, various geological formations (except creta-eous formation).

12. Sulfate rendzinas (gypsum).

Burozem Soils

13. Burozem soils[8] formed on gravelly and ocky deposits.

14. Burozem soils formed on sandy[9] and andy loam[10] deposits.

15. Fine-textured Burozem soils formed n boulder clay loam[11] and clay,[12] and fine-[13] nd medium-[14] textured Burozem soils formed n sand and sandy loam underlain with clay oam, clay-material and very fine clay.

16. Fine-textured Burozem soils formed on oulder clay loam and clay, and coarse-,[13] medium-[14] and fine-textured[15] Burozem soils formed on different clay loam and clay, except boulder clay.

17. Burozem soils formed on clays of various geological origin.

18. Burozem soils[16] formed on silt deposits of water origin.

19. Burozem soils formed on loess and loess-like deposits.

20. Burozem soils formed on rocks "Gaize" of cretaceous formation.

Podzolic Soils

21. Podzol soils formed on rocky and gravelly deposits.

22. Podzol soils formed on sandy and sandy loam deposits.

23. Heavy podzolic soils (formed on boulder clay and clay) and light and medium podzols formed on sand and sandy loam, underlain with clay loam, clay-material and very fine clay.

24. Fine-textured podzolic soils formed on boulder clay loam and clay, and coarse-, medium-, and fine-textured podzols (formed on various clay loam and clay, except boulder clay loam and clay).

25. Podzolic soils formed on very fine clay of various geological origin.

26. Podzolic soils formed on silt deposits of water origin.

27. Podzolic soils formed on loess and loess-like deposits.

Chernozems

28. Chernozems formed on loess deposits.

Black (dark-colored) Soils

29. Black soils formed on sandy and sandy loam deposits.

30. Black soils, coarse-, medium- and

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[7] Soils of river valleys formed on alluvial deposits nonwater-logged.

[8] Burozem soils with missing eluvial podzolic orizons in the profiles.

[9] Containing up to 10% particles <0.02 mm in iameter in the upper horizons.

[10] Containing 10%-20% <0.02 mm in diameter in e upper horizons.

[11] Containing 20%-50% particles <0.02 mm in dimeter.

[12] Containing 50% particles <0.02 mm in diameter.

[13] Containing up to 20% particles < 0.02 mm in ameter in the upper horizons.

[14] Containing 20%-35% particles < 0.02 mm in dineter in the upper horizons.

[15] Containing >35% particles < 0.02 mm in diameter in the upper horizons.

[16] Containing >40% silt particles 0.1-0.02 mm in diameter in the upper horizons.

fine-textured formed on clay loam, clay-materials and very fine clay of various origin.

31. Black soils formed on silt deposits of water origin.

Bog Soils

32. Very fine clay bog soils, peat soils and marsh soils.[17]

Mad Soils, River Mads

33. Sandy mads, river sands, coarse-, medium- and fine-textured.

Marine Mads

34. Marshes — soils developed on marine deposits. Soils in the initial stage of development.

35. Soils of districts disturbed by mountain and industrial use and soils of built-up distric formed from sand and sandy loam, clay loam and clay, and from various massive rocks.

Additional Legends

36. Symbol for basins in mountain districts

37. Symbol for group complexes of various podzolic and Burozem soils.

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[17] The marsh soils are found partly under excessive moisture conditions (formation of a peat humus), and partly under normal moisture conditions — the aerobic conditions (formation of an amorphous humus). Consequently, these soils also contain an amorphous humus, in addition to weakly humified organic compounds.

E MICROFLORA OF DECOMPOSING PLANT RESIDUE

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nces, USSR

'rom existing literature compiled by M. M. onova (4) and from her own investigations 2, 3, 5), it is known that the decomposition ant and animal residues to more simple nically separate compounds and partially roducts of complete mineralization is the phase in humus formation. The second e in humus formation is the synthesis of organic compounds with the formation of a ific nature of high molecular humus sub- ces.

'he first stage of humification is character- by an intensive development of mold fungi saprophyte bacteria. These organisms re- e the more easily assimilated nutrients of plant residues. It is in this period that de- position of the starch and partial decomposi- of the hemicelluloses, proteins, and cellu- takes place.

n the second stage of humification the sapro- e microflora is replaced by more specialized ups of microorganisms which require miner- itrogen. The processes related to the con- sion of the cellulose, which is decomposed ellulose-decomposing aerobic bacteria, ırr in this stage. During the death and de- position process, the slimy mass of myco- eria is changed into brown amorphous humus stances. At the end of the humification proc- a profuse development of actinomycetes is rved on the plant residues. These actino- etes are capable of utilizing the hard-to- mpose components of the plant tissues, as as the newly-formed humus substances.

ccording to Mishushtin and Timofeyeva (8), specially high-microorganism count is ob- ved during the decomposition of the plant dues in the first two to three months of posting. Fungi and non-spore-forming eria have particular significance in the first e of the decomposition of an organic sub- ce. The amount of actinomycetes increases icularly to the 45th day of the experiment. non-spore-forming bacteria almost disappear within two months while the fungi and actinomycetes remain for a longer period of time. When the development of non-spore-forming bacteria decreases, an intensive development of cellulose-decomposing bacteria is observed. A significant increase of spore-forming bacteria is characteristic for the second phase of the decomposition of plant tissue. The authors consider that the bacillary forms develop primarily because of the organic substances formed by the microorganisms during the first phase of the mineralization of a plant material.

Tepper (10) in his investigation points out the sequential change of the microflora during the decomposition of a summer straw.

According to Krasil'nikov and Nikitina (7), the roots of the decomposing plants have a noticeable effect on the quantitative and specific composition of the soil microflora. The composition of the microflora is different in the various stages of the roots' decomposition. The plant roots are not only a nutrient source but also aid in the separation of the microflora in the soil. Fungi develop in the initial stage of decomposition. Bacteria predominate in all stages of decomposition; non-spore-forming bacteria, which later change to spore-formers are the first to develop. Actinomycetes develop in profusion at the end of the decomposition of the root material.

Our experiments on the active soil microflora (9) have shown the possibility of simultaneously observing the complex of microorganisms which take part in soil processes.

By studying the active microflora of a layer of perennial grasses of varying degrees of decomposition, we were convinced that the complexes of microorganisms of various fractions of the layer have their own characteristic peculiarities. Thus, in fresh plant residues just added to the soil, the greatest quantity of microorganisms with a definite predominance of non-spore-forming bacteria, the presence of a large quantity of zoogloeaic forms, and almost a complete absence of actinomycetes, developed. A profusion of fungi and the appearance of mycobacteria is characteristic in the soil from November to May for straw rot that has not decomposed. For the same period of time, the highly-humified glass-covered portion of the plant residues was the worst with a definite predominance of actinomycetes and an increase in the relative quantity of cocci forms in the bacterial portion of the complex.

In this work we have analyzed the microflora of the plant residues of different botanical compositions that have decomposed under identical conditions. In addition to the active microflora, certain groups of microorganisms have been studied simultaneously by a method of seeding them onto a media.

Experimental Part

Our experiments on the microflora which brought about the decomposition of plant residues were conducted under laboratory conditions. Plant residues, on plots of saline solonetz from the territory of the Dzhanybek station in the western Kazakhstan region, were taken as objects of study:

1) a mixture of cultivated grasses — lesparto, brome grass, and a perennial steppe grass; 2) plant residues of a virgin soil steppe composed primarily of wormwood and a small quantity of Agnus castus; and 3) certain species of saltwort on solonchak from the Shala-Kupa lake.

Saline solonetz, taken from a plot of land which, after being plowed and seeded to a depth of 45 cm for two years, was covered with the foregoing grass mixture and used for the experiments.

Our problem was to create those conditions with which it would be possible to trace the microflora of the decomposing plant residues without mixing them with the soil and, at the same time, without eliminating the effect of the soil on this process. To achieve this purpose, the experiments were conducted in three-liter glass vessels. A drain was set in the bottom of the vessel which was then covered with non-alkaline fiberglass. 1.5 kg of soil, which had been previously sifted through a sieve with a 2 mm opening and moistened to 18%, was poured onto the fiberglass. The dried plant residues were cut into 1 cm pieces and placed into a thin non-alkaline fiberglass sack which had been previously boiled repeatedly in distilled water. An identical amount of plant residues was placed in each sack. Four to six sacks containing identical plant residues were placed in the vessel on top of the soil and then covered with an additional 1 kg of soil. The vessels were then covered with glass and moistened from the top through a tube. A vessel with soil, into which sacks filled wit same soil were placed, served as a control series of tests were conducted: the first se was conducted in April 1954 and the second August 1954. Both test series were termin simultaneously in February 1956.

The differences between Experimental S I and II was that in Series I the grass mixtu residues and virgin soil vegetation were co posed primarily of roots which were separa from the soil by washing with water. The p residues of Experimental Series II were se from dry monoliths. In addition to the root dues in the grass mixture, 4-5 cm of top sc were included. The sacks with the plant re dues of Experimental Series I were immers in water and left in a humidity chamber for hours before being placed into the vessels. Experimental Series II, each sack containir the plant residues was moistened with 5 ml water before the experiments were begun. differences in the moisture content of the p residues between Experimental Series I anc was retained throughout the entire experim The experiments were kept in darkness at r temperature with a variation from 20°-25°C the summer and from 18°-20°C for the rem der of the time.

The study of the microflora was conduct parallel with a study of the active microflor by innoculating them onto various nutrients. In the latter case, agar plates were placed two days in a sack with plant residues and i the soil directly below the residues. By th method of innoculation we took into account the bacteria which developed on the meat-p tone-agar (MPA); spore-forming bacteria o mixture of MPA and must-agar, non-spore-forming bacteria on glucose-asparaginic ag fungi on acid must-agar, actinomycetes on starch-ammonia, yeasts on must-agar at 7 Be, and cellulose-decomposing organisms on Hutcheson's medium.

Simultaneously with the microbiological analyses we took into account the moisture the soil and of the plant residues. The moi ture of the plant residues, as seen in Table was significantly higher than that of the soi for the entire period of the analyses, althou the plant residues lay in a thin layer and th fiberglass was not wetted and did not retai moisture.

The microbiological analyses indicated t the microflora of all groups of plant residu differed strongly from the microflora of th soil. As seen in Table 2 a tremendous am of bacteria and fungi developed in the first days of the experiment. The greatest amo of bacteria from the grass mixture and vir soil residues was observed on MPA in the first two to three weeks of the experiment. Later the bacteria count decreased unevenl

Table 1

Moisture content of plant residues and soil in percentages on a dry substance

Treatment	First Test Series April 13, 1954 — February 10, 1956									Second Test Series Aug. 4, 1954 — Feb. 10, 1956						
	1954							1955	1956	1954					1955	1956
	Apr. 13	Apr. 17	Apr. 26	May 13	June 21	Sept. 9	Nov. 16	Nov. 12	Feb. 10	Aug. 7	Aug. 14	Aug. 25	Sept. 13	Nov. 17	Oct. 13	Feb. 11
Plant residues																
Grass mixture	349	157	137	109	91	88	75	93	54	61	76	79	88	138	156	52
Virgin steppe grass	200	111	100	94	80	92	68	82	59	54	63	61	124	134	125	147
Saltwort	123	142	197	160	139	157	142	152	150	117	208	156	170	170	193	124
Soils																
Control	17	17	15	15	15	16	15	16	16	18	18	17	17	14	17	17
Under grass mix.	—	—	—	19	—	19	18	—	19	17	17	18	20	20	21	20
Under vir. steppe gr.	—	—	—	19	20	19	19	19	19	18	18	19	19	20	18	19
Under saltwort	—	—	—	18	22	23	23	23	23	18	19	20	20	19	18	19

t at the end it was still many times greater
ın that in the control soil. The greatest
ıount of bacteria growing on MPA was on the
ltwort; there for the duration of the experi-
ənt they were counted in the billions. A group
non-spore-forming bacteria (Table 3) flared
on the plant residues of the grass mixture
d virgin soil vegetation only in the first days
the experiment but later decreased sharply.
ore-forming bacteria grew profusely on all
pes of plant residues but was especially
ındant on the saltwort. Their relative quan-
y increased towards the end of the experiment
ereas their absolute quantity was almost con-
ınt.

The fungi count in the plant residues reached
ndreds of thousands, while in the saltwort
reached as much as tens and hundreds of
llions. Variations in the specific composi-
n of the fungi were observed at different
nes of the experiment. Thus, according to
G. Mirchink's definition, one species of
sarium, three species of Aspergillus, two
ecies of Penicillium, and one species of
ıcor were found in an analysis of the last
riod from the control experiment.

An obvious predominance of colonies of
species of Fusarium and to a lesser de-
ee, Mucor, Trichoderma, and Stemphillium
re noticed in the virgin steppe vegetation.
izopus nigricans was observed in the grass
xture with an almost complete suppression
other species. One species of Penicillium
m the section of Asymmetrica velutina from
saltwort was outstanding throughout all
dates. In the control soil the bacteria and
ıgi count was relatively low throughout all
es of the analyses. The number of actinomycetes in the saline solonetz was very high: they grew in the millions in the control soil. When innoculating from the plant residues of the grass mixture and virgin steppe vegetation, the actinomycetes were suppressed by the bacteria during the first periods of the experiment, but later they grew there in quantities greater than those in the soil. The actinomycetes in the Series I experiments from the saltwort grew only in the last test sample (within one year and ten months). In the Series II experiments having a lower moisture content in the plant residues, they appeared even within a month. The presence of yeast in the grass mixture and virgin steppe vegetation is characteristic for the first period of decomposition.

Regular changes during the innoculation of the aerobic cellulose-decomposing microorganisms were observed only in the saltwort; in the first two weeks a slight decomposition was caused by the bacteria and fungi, but this gradually increased and within a year the cellular tissue was completely destroyed by Dematium type fungi.

The microflora of the soil under the plant residues differed significantly from that of the control soil. The spore-forming bacteria count on the MPA was high here; the fungi and actinomycetes count increased more significantly only in the soil under the saltwort.

This indicates that decomposing plant residues enrich the microflora of a soil and that these microflora differ depending on the composition of the plant residues.

Thus, a profuse development of bacteria and

Table 2

Quantity of microorganisms per gram of plant residues and soil (in thousands)

Treatments	First Test Series April 13, 1954 — February 10, 1956							
	1954						1955	1956
	April 17	April 26	May 13	June 21	Sept. 9	Nov. 16	Oct. 29	Feb. 10
	Developed on Meat-Peptone-Agar							
Plant residues								
Grass mixture	48 421 000	5 342 860	904 250	1 601 900	308 020	219 700	196 150	74 600
Virgin steppe grass	8 800 000	1 976 000	371 000	196 250	41 000	66 250	58 270	9 160
Saltwort	55 000 000	16 550 000	5 025 000	22 431 200	2 683 750	65 000 000	14 193 750	23 875 000
Soils								
Control	3 060	2 730	2 080	3 600	2 290	4 420	8 990	4 780
Under grass mixture	—	—	14 406	17 625	11 250	7 125	—	10 915
Under virgin steppe grass	—	—	8 250	20 940	4 400	4 045	—	5 900
Under saltwort	—	—	92 700	60 190	36 930	67 075	—	74 650
Spore-formers								
Plant residues								
Grass mixture	1 376 300	726 200	2 042 550	96 150	205 660	34 210	107 700	63 800
Virgin steppe grass	8 060	12 490	10 580	14 830	9 000	6 250	7 450	2 440
Saltwort	17 930	Many	Many	3 540 000	2 681 250	628 130	1 408 130	1 431 900
Soils								
Control	670	650	1 440	900	430	590	510	1 690
Under grass mixture	—	—	19 060	1 690	3 730	2 030	—	7 170
Under virgin steppe grass	—	—	1 375	1 630	1 690	580	—	3 500
Under saltwort	—	—	15 500	14 810	4 720	110	—	26 406

Table 2 Continuation

Treatments	First Test Series April 13, 1954 — February 10, 1956							
	1954						1955	1956
	April 17	April 26	May 13	June 21	Sept. 9	Nov. 16	Oct. 29	Feb. 10
Fungi								
Plant residues								
Grass mixture	658	317	172	414	40	103	372	208
Virgin steppe grass	530	620	172	79	55	89	165	159
Saltwort	1 056	166 000	208 000	105 250	Many	102 375	5 092	1 930
Soils								
Control	29	18	18	14	5	15	14	17
Under grass mixture	—	—	16	6	3	12	—	26
Under virgin steppe grass	—	—	53	25	5	7	—	29
Under saltwort	—	—	313	262	151	230	—	81
Actinomycetes								
Plant residues								
Grass mixture	None	None	7 702	29 000	11 790	13 717	52 403	11 038
Virgin steppe grass			27 400	8 183	7 180	26 583	8 636	9 047
Saltwort			None					1 750
Soils								
Control	1 258	2 005	4 471	2 624	2 325	2 578	1 508	5 700
Under grass mixture	—	—	3 928	2 163	2 671	2 006	—	4 831
Under virgin steppe grass	—	—	5 072	3 472	1 394	1 584	1 286	3 885
Under saltwort	—	—	17 109	52 850	787	2 869	—	681

Table 2 Continuation

Treatments	Second Test Series August 4, 1954 — February 11, 1956						
	1954					1955	1956
	August 7	August 14	August 25	Sept. 13	Nov. 17	Oct. 13	Feb. 11
	Developed on meat-peptone-agar						
Plant residues							
Grass mixture	4 056 000	6 430 000	4 146 000	960 000	3 000 000	1 416 000	76 100
Virgin steppe grass	4 331 000	9 032 000	4 500 000	1 004 000	409 000	386 000	104 500
Saltwort	1 465 000	13 461 000	11 494 000	11 061 000	9 491 000	12 240 000	15 061 000
Soils							
Control	1 300	6 500	22 900	4 900	8 900	9 800	10 000
Under grass mixture	75 000	48 600	7 000	8 900	10 900	—	9 500
Under virgin steppe grass	4 200	29 500	39 500	18 500	14 000	—	15 100
Under saltwort	111 000	191 000	—	30 700	28 000	—	56 300
	Spore-formers						
Plant residues							
Grass mixture	Very many	296 900	1 372 730	256 600	178 000	1 125 000	41 150
Virgin steppe grass		622 000	870 000	785 230	551 000	86 000	66 800
Saltwort		Very many	1 391 000	1 388 000	1 608 000	1 746 000	2 868 000
Soils							
Control	2 260	540	600	1 440	1 000	530	3 390
Under grass mixture	1 050	2 650	3 500	6 860	1 360	—	6 260
Under virgin steppe grass	5 000	5 650	2 980	7 400	2 130	—	10 500
Under saltwort	Very many	6 320	2 300	7 600	1 500	—	69 000

Table 2 Continuation

Treatments	Second Test Series August 4, 1954 – February 11, 1956						
	1954					1955	1956
	August 7	August 14	August 25	Sept. 13	Nov. 17	Oct. 13	Feb. 11
	Fungi						
Plant residues							
Grass mixture	878	Many			3 095	250	1 050
Virgin steppe grass	889	524	18 709	2 900	492	186	450
Saltwort	152	21 250	207 000	54 166	43 750	42 125	57 784
Soils							
Control	11	11	8	5	8	6	8
Under grass mixture	17	12	89	36	42	—	5
Under virgin steppe grass	19	1	14	11	13	—	47
Under saltwort	15	38	81	156	220	—	196
	Actinomycetes						
Plant residues							
Grass mixture	435	—	An increase of Bacteria		73 000	443 750	33 460
Virgin steppe grass	804	—	None	289 545	160 000	55 170	48 750
Saltwort	0	—	"	1 083	10 277	3 000	1 590
Soils							
Control	446	—	8 676	8 029	6 637	2 388	2 850
Under grass mixture	941	—	7 380	5 481	5 873	—	4 970
Under virgin steppe grass	505	—	7 619	6 369	3 162	—	2 320
Under saltwort	470	—	13 493	9 548	6 957	—	1 964

Table 3

The quantity of non-spore-forming bacteria growing on glucose-asparaginic agar per gram of dry substance (in thousands)

Treatment	First Test Series April 13, 1954 — February 10, 1956			Second Test Series Aug. 4, 1954 — Feb. 11, 1956	
	April 17	April 26	May 13	August 7	August 14
	1954				
Plant Residues					
Grass mixture	2 456 580	25 000	15 035	2 260 000	125 000
Virgin steppe grass	3 095 000	34 000	67 950	75 000	4 000 000
Saltwort	3 830		None		50 000
Control soil	None		188	None	333

Table 4

The quantity of yeasts per gram of dry substance (in thousands)

Test variant	April 17	April 26, 1954
Grass mixture	1 000	1 942
Virgin steppe residues	1 940	9 060
Saltworts	0	0
Control soil	0	0

fungi is observed in the plant residues especially during the first period of their decomposition; the actinomycetes appear later. A rich growth of non-spore-forming bacteria and yeasts is characteristic for the virgin steppe and grass mixture in the early stages of decomposition. The absolute number of spore-forming bacteria varies slightly throughout the entire experiment. A significantly large number of fungi and bacteria is characteristic for the saltworts in comparison with the other treatments. One species of Penicillium stands out from the saltworts in an overwhelming quantity.

Active Microflora of Decomposing Plant Residues. Control

The Petri plates in the control experiment were similar during all periods of analyses. The plates were well covered and all groups of microorganisms developed. Here and there the fungi formed a network of mycelium, and in certain cases a slight formation of spores was observed. The actinomycetes were the dominant organisms in the majority of pr parations and comprised the main part o microflora. They were observed in the of well-shaped microcolonies and a stron interlocked mycelium having lost its stru ture (Fig. 1). Here and there a formati of rods from filaments and a fragmentati of mycelium were observed. Bacteria significantly less in comparison with the actinomycetes. Spore-forming bacilli, forming microcolonies and a conglomerat near the soil particles, were predominar among them. This variety is the large bacilli, often with strongly vacuole-form plasma or with spores. The usual cyli drical, cigar-shaped clostridium and ple trium bacilli of the B. megatherium type with a polar nucleus, are among them (1 2). The small bacilli (cocci bacilli and cocci) of the non-spore-forming bacteria are present to a much lesser degree and were observed at various times in single colonies or in groups. A small number amoebae were noticed during certain per of the analyses.

Grass Mixture and Virgin Soil Plant Residues

The microflora of the grass mixture and rgin steppe vegetation were similar in both xperimental series and differed sharply from ie control soil both in the intensity of the growth nd in the composition of the basic groups of icroorganisms. These differences lasted al- ost throughout the entire experiment and then vened out after one and a half years of de- omposition.

The microflora were quite different forms the first week of the decomposition of the ant residues. Non-spore-forming bacteria, hich consisted of various rod-shaped and occus forms, predominated. Zoolgloeaic rms (Fig. 3), which occupied large areas the preparations, had developed to a large egree among the bacteria. Short thick bacilli, hich lay in well-formed slimy capsules; large asses of mycobacteria; fields of cocci and icrocolonies of oval-shaped cells (Fig. 4) ere present in relatively large numbers. pore-forming bacteria were also encountered a large quantity. These are the well-shaped acilli with a central spore which were usually ocated in diffused masses, oval forms with pores, and less seldom in plectrum forms.

The fungi were well developed and produced large quantity of spores and chlamydospores. ere it was possible to encounter forms simi- r to Alternaria, Verticillium, and Phycomy- es. The actinomycetes in this period were ther absent or developed in insignificant ımbers. The characteristic microorganisms r the first ten days of decomposition were the icrocolonies and masses of yeasts (Fig. 5). the first 15 days of the experiment a rich evelopment of amoebae, which fed on the cteria, was observed (Figs. 5, 6). Later e number of amoebae decreased, however the noebae continued to remain in a sufficiently rge amount in the preparations throughout five onths of the experiment. A mass autolysis of e bacteria, a mass spore formation of the pore-forming bacteria and fungi, and a rapid ging and vacuole formation of the fungi fila- ents and amoebae bodies has been periodically oserved in the preparations of the early periods. e observed the effect of the autolysis of the cterial bodies in the preparations of Experi- ental Series I on the 7th, 14th, and 30th days; identical picture was observed in the prepara- ons of Experimental Series II. In the later eriods of the experiments (150 days, for ex- nple) the number of amoebae decreased narply and actinomycetes appeared in a sig- ficant number. In the year-and-a-half long periments the active microflora of the plant esidues approached the composition of the tive microflora of the soils in which, in both ses, the actinomycetes and spore-forming cteria remained the dominant forms (Fig. 7). Fungi and non-spore-forming bacteria were observed in a lesser amount while amoebae were almost absent.

Thus, an absolute domination of non-spore-forming bacteria throughout the first month of the experiment is characteristic for the grass mixture and virgin steppe vegetation; later the non-spore-forming bacteria remained in large numbers but spore-formers developed almost to an equal degree along with them. A noticeable predominance of non-spore-forming bacteria was observed only in the virgin steppe plant residues. Zoogloeaic forms with a clearly defined slimy capsule were predominant in the first 14 days but they decreased in the later periods. In the first week we saw a large number of yeasts which later died out. Amoebae were present in large numbers in the complex of microorganisms until the 150th day of the experiment. An autolysis of the microbial forms as well as the vacuole formation and decomposition of the bodies of the amoebae was periodically observed in the preparations.

Soil Under Grass Mixture and Virgin Steppe Plant Residues

In the initial period of decomposition the soil under the plant residues differed from that of the control by the great intensity of the overgrowth. Here all forms living in the soil were retained while new microbial forms, which had developed in the plant residues, appeared. Thus the microflora of the soil under the plant residues has an intermediate character that is between the microflora of the soil and that of the plant residues. For example, actinomycetes were dominant in the preparations of the 10th day just as in the control soil; the fungi count was greater than in the control soil and non-spore-forming bacteria were present in significant numbers and were composed primarily of zoogloeaic forms, cocci bacilli, mycobacteria, and diplococci, i. e. those forms characteristic for plant residues. The count of spore-formers was high and was composed of the same forms as in the control soil. Amoebae were encountered in a small quantity. At a much later period in the decomposition of the plant residues, the microflora of the soil under the residues differed slightly from that in the control soil (Fig. 8).

Saltworts

The active microflora of the decomposing saltworts differed sharply from that of the grass mixture and virgin steppe vegetation. In Experimental Series I where the saltworts were much more moist in comparison with Series II, the overgrowth of the Petri plates began immediately after the experiment had

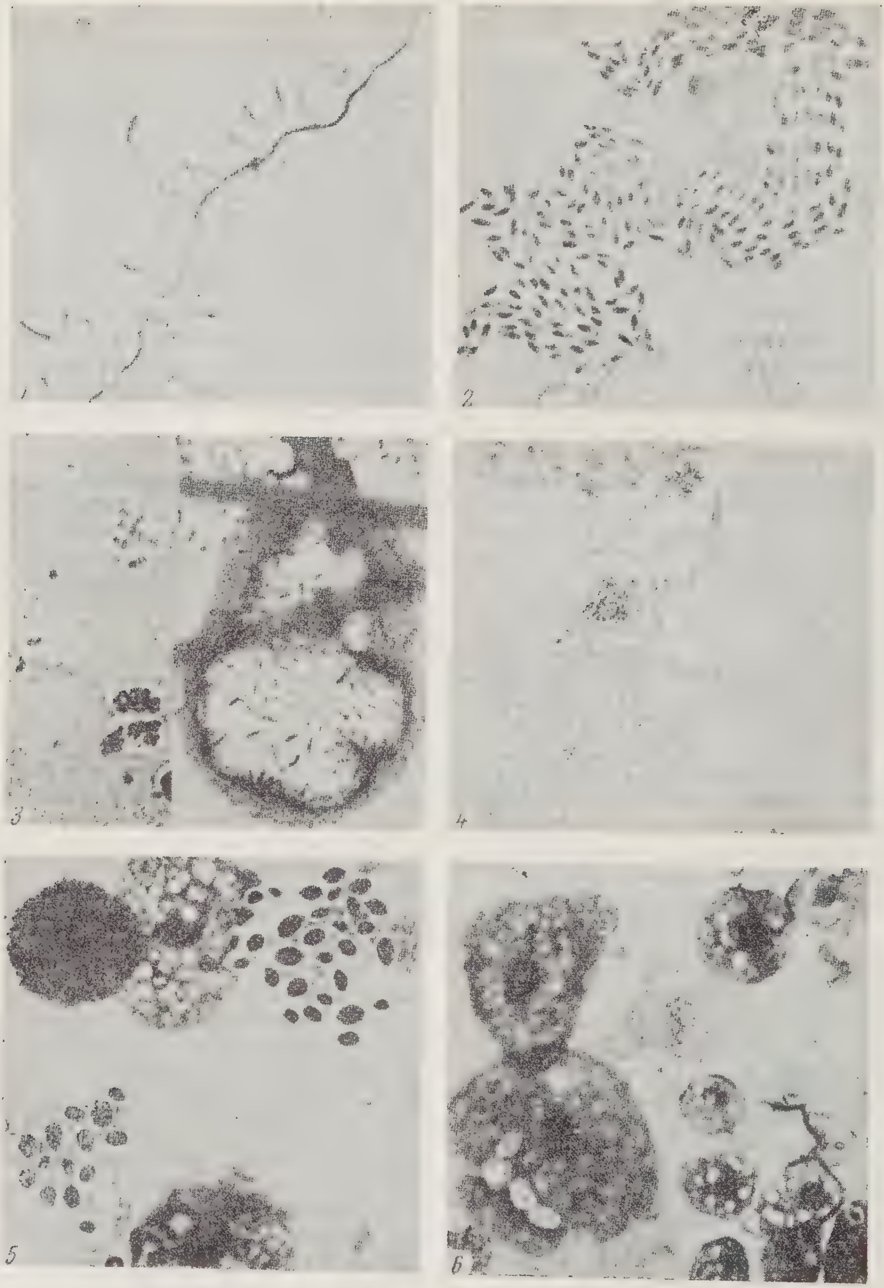
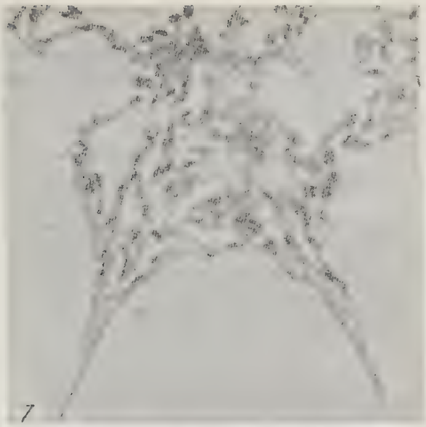
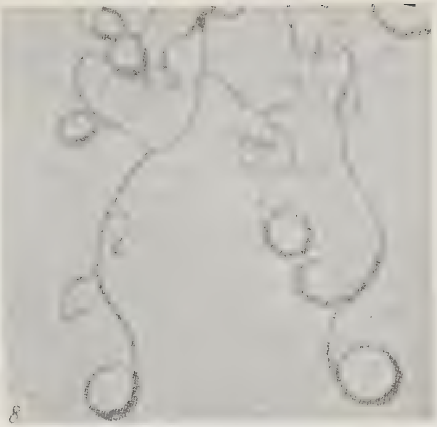
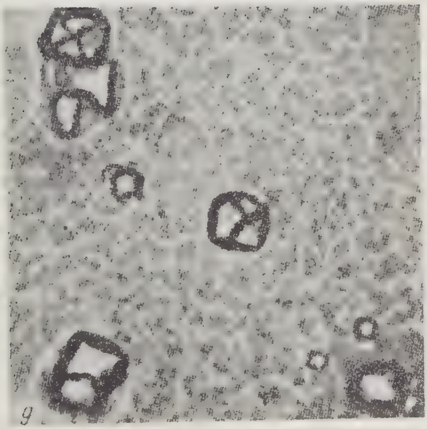


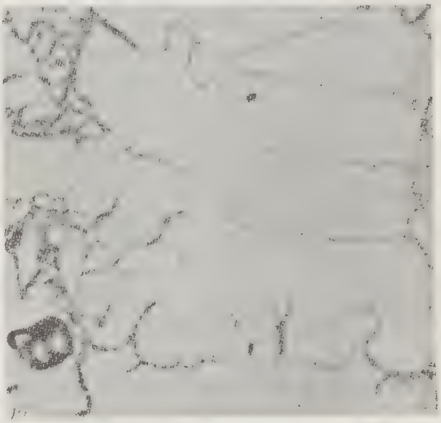
Fig. 1. - Mycelium of actinomycetes.
Fig. 2. - Microcolonies of spore-forming bacilli.
Fig. 3. - Zoogloeaic forms among non-spore-forming bacteria.
Fig. 4. - Mycobacteria and cocci.
Fig. 5. - Yeasts and amoebae among small bacteria.
Fig. 6. - a - an amoeba with bacteria inside the body b - a group of amoebae.

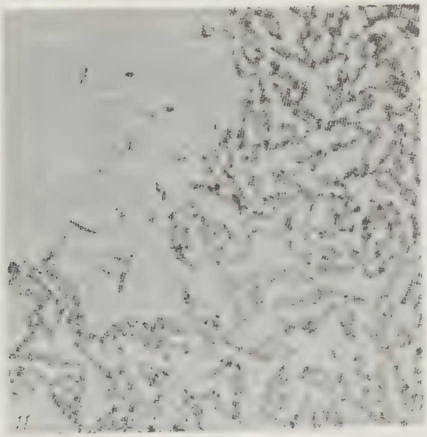
begun. In the first two days of Experimental Series II there was no overgrowth of the Petri plates but a mass deposit of crystals was observed on them. Later these crystals were observed singly (Fig. 9). An intensive development of active microflora began three to four days after the start of the experiment and continued to the end. Fungi grew as in hotbeds It was possible to observe a profusion of spore Penicillium with a slight development of











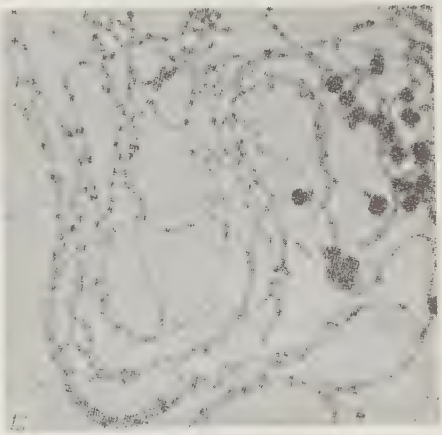


Fig. 7. - A microcolony of spore-forming bacilli.
Fig. 8. - Mycelium of actinomycetes.
Fig. 9. - Crystals among cocci.
Fig. 10 - Microorganisms of the proactinomycetes type.
Fig. 11. - A conglomeration of bacilli with pointed spores.
Fig. 12. - Bacilli with pointed spores forming long chains.

nycelium on the Petri plates beginning from he third day and up to a year. It was only in he preparations of fourteen months that the ungi developed intensively, their mycelium formed a sufficiently bushy meshwork of young, finely-branching hyphae, retained here and there in rods. Here it was also possible to observe an accumulation of spore Penicillium, a portion of which had germinated. In much later preparations the fungi were again observed in a small quantity and were in a poor state in which a peculiar branching, a destruction and partial lysis of the hyphae and the formation of fungi and chlamydospores was noticed. At certain periods it was possible to observe the destruction of the fungi spores on the Petri plates by bacteria. Actinomycetes were completely absent in the preparations in the first 14 days but later organisms, which were similar to proactinomycetes (Fig. 10), began to appear. Later, a small quantity of typical actinomycetes, to which mycobacteria and mycococci were attached, appeared. The dominant flora in the first five months of decomposition were the non-spore-forming bacteria which were composed of masses of cocci and bacilli, lying in dense zoogloea and sometimes in forms approximating mycobacteria. In the preparations, after a year of plant residue decomposition, the quantity of non-spore-forming bacteria decreased sharply. Primarily coccus bacilli and micrococci were observed at this time. The quantity of spore-formers in the first days of decomposition was insignificant but increased rapidly; within five months they had increased to such an extent that they now belonged to the dominant flora which included an overwhelming quantity of thin bacilli, forming round, ring-shaped spores, morphologically similar to the stimulants of hydrogen and methane fermentation of cellular tissue. These forms were very constant in the preparations from the beginning to the end of the experiment; they formed microcolonies and conglomerations as well as being located in the preparations in a diffused mixture with non-spore-forming bacteria (Figs. 11 and 12). Yeasts appeared in the early stages of decomposition in the form of small masses. Amoebae were present in the preparations in a significant quantity in the first months of the experiment but it was also often possible to see them in an encyst state. Towards the end of the experiments (14 to 18 months), the microflora of the decomposing saltworts approximated the microflora of the control soil.

Soil Under the Saltworts

Actinomycetes were the dominant microflora in the composition of the active microflora of the soil under the saltworts, just as in the control soil, throughout the entire experiment. Fungi developed poorly in the form of separate hyphae and masses of spores lay here and there. Non-spore-forming bacteria developed intensively in large conglomerations of bacilli and micrococci as well as in capsule forms. Mycobacteria were encountered less frequently. Plectrum forms, which are characteristic for saltworts, were present in a large amount from the spore-forming bacteria. Non-spore-formers remained in a small quantity for much longer periods of time (for instance, for 150 days of the experiment).

After the experiment was terminated, the plant residues externally differed strongly fr the original residues. They acquired a dark brown coloring. The plant residues of the grass mixture and virgin steppe were easily pulverized, turning into a homogenous dark brown mass although still continuing to retain their original form. The saltworts quickly changed their original form; at the end of the experiment they were a homogenous brown pasty mass in which the well preserved seed coverings were included.

Thus, in the decomposition of plant residues of varying botanical compositions, a complex set of microorganisms, the composition of which changes constantly during the decomposition process, takes part. A microscopic study indicated that bacterial forms and amoebae producing the slimy capsules occupied a large area in this complex. The autolysis of the microbial bodies that was periodically observed aided in the enrichment of the medium with substances from a microbial synthesis, changing it and then causing the development of new microorganisms.

The process of continual microflora development and change is dependent on the change of the medium because the decomposing plant residues create a basis for the qualitative formation of new types of humus substance

Conclusions

1. The decomposition of plant residues is produced by an intricate complex of various microorganisms, the composition of which changes during the decomposition process.

2. Non-spore-forming bacteria which form a large amount of slimy capsules, as well as the yeasts, fungi, and amoebae play a dominant role in the early period of decomposition. Later it is the spore-forming bacteria and actinomycetes that play the dominant role.

3. The complexes of microorganisms which decompose the plant residues of the grass mixture and virgin steppe, are similar in themselves, but differ sharply from those in the saltworts. This is determined obviously by the chemical composition of this type of plant.

4. The microflora of decomposing plant residues differs from that of the soil by the sharp increase in the number of microorganisms and by the change in their species composition.

5. The processes which occur during the decomposition of the plant residues have an effect on the soil under the residues by changing

quantity and species composition of its roflora. These changes, however, are hort duration and take place only in that od when the decomposition of the plant dues occurs. The microflora remains lar to that of the soil in the residues of different variants that have been humified.

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FERTILITY OF RECENTLY CULTIVATED SOD-PODZOLIC SOILS OF THE SOUTHERN TAIGA OF OMSK REGION[1]

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New lands are now being cultivated in the taiga areas of Omsk region by putting the sod-podzolic soils to agricultural use after felling the trees and grubbing out their roots.

In contrast to the southern areas of the region, where recently cultivated lands are most often quite extensive, grubbing and cultivation are done mainly on small tracts in the northern regions and intended chiefly to further the organization of the economy of the territory. Thus, in the kolkhozes of Vasiss district the cultivated area at present averages 16.6% of the total land area in use (3). The fields are small tracts of irregular shape scattered through the forest. This sort of land use on this scale is not in accordance with our present technical level and markedly lessens both the productivity of machinery and the productivity of labor on the kolkhozes. Clearing will unify the fields, give them the proper configuration, and eliminate strip-tenancy.

Grubbing is practiced usually on deciduous (birch, aspen) or mixed (usually with birch) forests, which have replaced the original coniferous forests that were eliminated when the land was settled, starting about 60 years ago. Coniferous forests, which are few in the populated part of the southern taiga, are rarely grubbed.

Newly cultivated lands on the right side of the Irtysh (Vasiss district, the right-bank portion of Tara district) are poor, sod strongly podzolic soils of coarse texture (coarse texture (coarse clay loams, sandy soils). The humus horizon of these soils is not more than 5-7 cm thick, and the podzolic horizon is up to 31-48 cm thick. Nevertheless the local people rate them highly for their fertility as compared with the long-cultivated soils that (as a rule) have not been manured for decades. Newly cultivated lands are usually sown to spring wheat, which is planted for a number of years, unti signs of exhaustion begin to appear. Often the first crops sown after grubbing are winte rye or flax, and after them, beginning with the second year, spring wheat.

Data are given in Table 1 showing the con parative yields of spring wheat on newly cultivated and long-cultivated plots. The plots compared (control plots in our experiments with fertilizer) were located within a single field and separated by a distance of a few tens of meters; these were worked and seede simultaneously. As is evident from Table 1, the yields of spring wheat on the newly cultivated tracts was considerably higher (1.4-2.1 times) than on the corresponding long-cultivated fields given the same treatment.

The higher fertility of the newly cultivate plots is obviously associated with the improv plant nutrients provided by the organic residues of the litter and humus layer. From ou determinations the quantity of organic residu of the litter and upper layer of the soil (0-20 cm) in a deciduous forest (Kirov kolkhoz) totalled 52 metric tons per ha. We may assu that above all the newly cultivated soils prov a relatively high level of nitrogen to the plan

To find the type of nitrogen mobilization i the newly cultivated soils, we carried out a laboratory experiment in which soil from different plots was composted in a thermosta with moisture equalling 60% of the maximum moisture capacity and at a temperature of 24 28°C. After a definite time interval the soil was analyzed for its nitrate content and the biological activity of the soil was assessed b Shtatnov's method (5) from the rate of CO_2 liberation. The experimental data are presented in Tables 2 and 3.

As we see from Table 3, nitrates were accumulated in considerably greater quantiti in the soil from intact and recently grubbed areas in the forest than in the long-cultivate soils. But the accumulation of nitrates in

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[1] Presented to the First Delegates' Convention of Soil Scientists, May, 1958.

Table 1

Yields of spring wheat, cntr/ha, for newly cultivated and long-cultivated soils. The soils were sod, strongly podzolic, sandy soils.

Year and location	No. of paired experiments	Plots	
		Newly cultivated after grubbing	Long-cultivated
1956	1	20.6	11.8
Kirov kolkhoz, Vasiss district	2	19.5	10.0
1957	1	16.2	7.6
Zhdanov kolkhoz, Tara region	2	21.3	15.1

Table 2

Chemical characteristics of the soils of the experiment with composting[a]

Plot	Layer, cm	pH of salt extract	Total adsorbed cations	Hydrolytic acidity	Degree of base saturation	Mobile Al, mg/100 g	Humus, % (after Balabaya)	P_2O_5	K_2O
			meq/100 g					mg/100g	
								After Kirsanova	After Peyve
Forest (virgin)	0—10	5.4	13.8	4.6	75	3.9	5.0	3.8	10.5
	10—20	5.0	2.9	2.4	54	1.6	0.9	3.8	3.8
Winter rye 1st crop after grubbing	0—10	4.9	15.4	6.8	69	2.3	4.9	2.5	12.6
	10—20	5.2	1.9	4.2	31	1.0	1.2	2.5	—
Winter rye on long-cultivated land, non-fertilized	0—10	5.4	4.8	3.0	62	0.7	1.6	2.5	3.8
	10—20	5.2	4.2	3.2	57	1.2	1.2	2.5	3.8
Same, manured	0—10	5.4	7.7	3.8	67	1.5	2.7	5.0	15.8
	10—20	5.0	5.1	3.6	58	1.2	2.1	6.3	19.0

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[a] Sod, strongly podzolic, sandy soil. Samples taken in Kalinin kolkhoz, Vasiss district, ugust 8, 1955.

gin soils does not begin right after the es-
ishment of favorable conditions of aeration,
sture, and temperature. The initial period
omposting is characterized by high biologi-
activity. In their rapid decomposition of
anic material low in nitrogen the microbes
lently utilize mineral forms of nitrogen
their biological fixation. Later on the biological activity slacks off and accumulation of nitrate nitrogen begins.

It should be mentioned, however, that the compost-analysis data reflect only the relative potential richness of the soils of the different plots. They show the extent to which it is possible to provide plants with

Table 3

Biological activity and nitrification capacity in composts[a]

Plot	Layer, cm	Biological activity, mg CO_2/100 g soil in 20 hr				Nitrification capacity, mg nitrate/kg soil			
		2d-3d	6th-7th	24th-25th	43d-44th	Before	After 10	30	60
		Days of composting							
Forest (virgin)	0—10	>33.3	>33.3	27.3	7.7	0	0	76.9	300.2
	10—20	13.6	4.8	2.9	0.8	0	0	18.2	32.
Winter rye 1st crop after grubbing	0—10	>30	29.5	11.3	—	6.8	131.1	235.6	—
	10—20	11.5	6.8	4.5	2.1	0	0	35.0	74.
Winter rye on long-cultivated land, non-fertilized	0—10	6.4	3.8	2.1	0.7	0	10.8	35.0	4.0
	10—20	6.5	3.2	1.4	1.3	0	13.2	25.5	30.4
Same, manured	0—10	12.0	7.4	4.1	1.9	2.8	29.7	43.2	54.9
	10—20	6.2	3.3	1.8	1.3	2.8	8.5	21.2	50.5

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[a] Sod, strongly podzolic, sandy soil. Samples taken on Kalinin kolkhoz, Vasiss district, August 8, 1955.

Table 4

Content of nitrate and ammonium nitrogen in the soil in the planting season for spring wheat,[a] mg of N/kg of soil

Plot	Layer, cm	Kirov kolkhoz, Vasiss district May 22, 1956		Kirov kolkhoz, Vasiss district May 25, 1957		Zhdanov kolkhoz, Tara district, May 24, 1957	
		NO_3	NH_4	NO_3	NH_4	NO_3	NH_4
Grubbed	0—20	2.5	73.7	8.2	34.0	4.6	42.3
	20—40	0.0	64.0	5.3	23.2	3.2	22.7
	40—60	0.0	52.0	—	—	4.9	27.8
Long cultivated	0—20	2.2	157.2	6.8	21.4	4.9	21.7
	20—40	1.5	76.4	6.0	21.6	7.0	23.2
	40—60	1.2	60.0	—	—	3.9	30.8

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[a] Nitrate nitrogen was determined in the water extract 1:5; ammonium nitrogen, in the extract with 0.1 N solution of KCl, 1:30.

mineral forms of nitrogen in newly cultivated soils as compared with those long under cultivation. They emphasize the importance of processes leading to the biological fixation of nitrates, processes associated with the increased biological activity of the reclaimed soils.

Under natural conditions the situation is more complicated and less favorable than in the la oratory experiments. In 1956 and 1957 we observed the nitrogen regime of soils in plo in different states of cultivation. From the data in Table 4 we see an appreciable difference between the two years of observations regards the amounts of available forms of ni trogen in the soil during the planting period ring wheat; in 1957 there were more of the rate and less of the ammonia nitrogen than 1956. But, disregarding this difference, we te that in 1956 and 1957 the amounts of ni- ates in the soils were small and considerably wer than the amount of adsorbed ammonia, and so that, as regards the concentration of available forms of nitrogen, the grubbed soils do not fer from those long under cultivation.

If we consider only half the nitrogen of the sorbed ammonia to be available to the plants, Peterburgskiy shows (1), then the total con- ntration of nitrogen in the layer from 0-20 cm at could be used by plants at planting time for ring wheat turned out as follows in 1957.

Judging from the data of Table 5, the spring heat was well supplied with nitrogen even in e initial growth period. If 1 mg of N in 1 kg soil corresponds to 3 kg of N per ha, then the nount of nitrogen in the plow layer was from -77 kg/ha in the cases cited. But actually e wheat did not get enough nitrogen and re- onded to the addition of nitrogenous fertilizers, we saw previously, with considerably in- eased yields. Evidently the level of avail- ility of the nitrogen of adsorbed ammonia is ry small — lower than ordinarily assumed. e of the causes of this low availability of il ammonium in the soils we studied is eir acid reaction (pH of the salt extract erages about 5.5).

For a clearer notion of the character of the rtility of the newly cultivated soils and also shed light on the question of the effects of ineral fertilizers on these soils (as compared their effect on the soils long under cultivation), we conducted field experiments in 1956 d 1957 with spring wheat.

We should mention that the few data we ve from experiments on the effectiveness of rtilizers in the taiga zone of Western Siberia, cording to information from the Narym State ed Culture Station, testify to the great im- rtance of both organic and mineral fertilizers r spring wheat (2). Our experiments were in l cases set up in pairs: each experiment on newly cultivated land was matched to an experiment on long-cultivated land (or on cultivated briefly abandoned land) located in the same field. As noted previously, these paired experiments were worked and planted in the same way and at the same time.

The soils in all the experiments were sod strongly podzolic, coarse sandy loams. Their chemical characteristics are given in Table 6. These show that soils of the experiments are distinguished by a low acidity: the pH of the salt extract is between 5.2 and 5.8, the degree of saturation is about 70%, and mobile Al (exchangeable acidity) is practically absent. At the same time the acidity of the newly cultivated soils is somewhat higher than that of those long under cultivation.

Both the newly cultivated and the long-cultivated soils are very low in available phosphorus. The potassium content in soils of the experiments in most cases was enough to furnish an average to low supply of this element to the plants. The newly cultivated soils contained somewhat more potassium than the long-cultivated soils.

The size of the plots in the experiments was 150-200 m² and there were two replicates. The fertilizers were mixed in with the harrow or the cultivator the day before or on the day of planting. The variety of spring wheat used in all the experiments was "diamant." Yields were determined by harvesting test areas. The yield data for the experiments are given in Tables 7 and 8.

The 1956 experiments (Table 7) gave somewhat unexpected results; the addition of superphosphate alone did not increase the yield but rather reduced it (in three cases out of four); the most marked reduction was observed on the newly cultivated soils. The addition of ammonium nitrate to the superphosphate increased the yield, bringing it up to the yield of the fertilized plot in some experiments, and in others, producing a small excess. The unfavorable effect of superphosphate on the yield of spring wheat apparently is explained by some reduction

Table 5

Total content of nitrogen available to plants in the 0-20 cm layer in the planting period for spring wheat

Place of observation	Nitrate nitrogen + 1/2 ammonium nitrogen, mg/kg of soil	
	Grubbed	Long cultivated
Zhdanov kolkhoz	4.6+21.2=25.8	4.9+10.8=15.7
Kirov kolkhoz	8.2+17.0=25.2	6.8+10.7=17.5

Table 6

Chemical characteristics of soils in the experiments with spring wheat (0-20 cm layer)

No. of experimental pairs	Experiment No.	Plot	pH of salt extract	Total adsorbed bases, meq/100 g	Hydrolytic acidity, meq/100 g	Degree of base saturation, %	Exchangeable acidity, meq/100 g	Humus, %	Total N, %	P_2O_5, mg/100 g (after Kirsanova)	K_2O, mg/100 g (after Peyve)
Kirov kolkhoz, Vasiss district, 1956											
1	1	2d crop after grubbing, 1954	5.2	6.2	3.4	65	0.13	1.79	not det.	3.1	15
	2	Long cultivated	5.8	9.0	3.4	72	0.10	2.51	"	5.0	9
2	3	3d crop after grubbing, 1954	5.2	7.6	3.9	66	0.10	2.52	"	3.7	9
	4	3d crop after plowing abandoned land	5.4	5.9	3.2	65	0.08	1.89	"	2.5	9
Zhdanov kolkhoz, Tara district, 1957											
1	1	2d crop after grubbing, 1955	5.3	6.1	3.5	64	0.11	3.07	0.18	1.2	9
	2		5.9	7.6	2.2	78	0.11	2.32	0.12	3.7	6
2	3	3rd crop after grubbing, 1956	5.4	9.4	3.9	71	0.11	3.44	0.16	2.5	9
	4	2d crop after plowing abandoned land	5.6	10.1	3.5	74	0.11	3.30	0.17	1.8	5

Table 7

Yield data for experiments with spring wheat, 1956 (cntr/ha)
Kirov kolkhoz, Vasiss district

Fertilizers	Experiments: No. 1 2d crop after grubbing	No. 2 long-cultivated	No. 3 3d crop after grubbing	No. 4 3d crop after plowing of aband. land
No fertilizer	20.6	11.8	19.5	10.0
Superphosphate, 2.5 cntr/ha	16.2	11.8	16.2	9.1
Superphosphate, 2.5 cntr/ha + amm. nitr., 1cntr/ha	22.1	10.8	19.4	13.0

of the nitrogen supply to plants as a result of the biological consumption of nitrates by the microflora, which is strongly increased in the presence of phosphorus.

Regarding the slight effect (or absence of effect) of the double fertilizer NP, we assume that here the trouble is caused by the lack of potassium in the fertilizer containing ammonium nitrogen (5). This assumption was confirmed in the 1957 experiments, where potassium wa included (Table 8).

As we see from Table 8, in both the 1957 a 1956 experiments the addition of superphospha alone did not increase the wheat yield. Combination fertilizers containing nitrogen affecte a considerable yield increase. For one, the

Table 8

Yield data for experiments with spring wheat, 1957 (cntr/ha)
Zhdanov kolkhoz, Tara district

Fertilizers[a]	Experiments							
	No. 1 2d crop after grubbing		No. 2 long-cultivated		No. 3 2d crop after grubbing		No. 4 2d crop after plw. of aban. ld.	
	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase
O	16.2	—	7.6	—	21.3	—	15.1	—
P_s	16.1	—0.1	6.9	—0.7	20.3	— 1.0	—[b]	—
N_{an} P_s	21.7	+5.5	12.5	+4.9	26.4	+ 5.1	—[b]	—
N_{an} Kcl	—	—	—	—	31.4	+10.1	23.1	+8.0
N_{an} P_s K_{cl}	24.9	+8.7	15.8	+8.2	28.0	+ 6.7	—[b]	—

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[a] Amounts of fertilizer: P_s — superphosphate at 3 cntr/ha; N_{an} — ammonium nitrate at 1.5 cntr/ha; K_{cl} — potassium chloride at 1 cntr/ha.

[b] Unreliable values (replicates did not agree).

Table 9

Yields of spring wheat from pot experiments. Sandy loam podzol (virgin, from forest), Usul'gan valley, Vasiss district

Fertilizers	1956					1957				
	Wt. of grain		No. of spikes per plant	No. of kernels per container	Wt. of 1000 kernels per cont.	Wt. of grain		No. of spikes per plant	No. of kernels per container	Wt. of 1000 kernels per cont.
	g/container	%				g/container	%			
O	3.5	100	1.0	144	23.9	2.3	100	1.0	109	20.8
N_{an} P_s	9.8	280	2.4	405	21.6	1.1	48	1.0	95	11.7
P_s K_{cl}	4.2	120	1.0	158	26.4	3.1	135	1.0	125	24.3
N_{an} K_{cl}	10.0	286	1.8	324	30.9	5.0	217	1.0	179	27.9
N_{an} $P_s K_{cl}$	11.7	334	2.6	463	25.2	8.5	369	1.3	310	27.4

uble NP fertilizer, the weak effect of the
evious year persisted. The highest increase
the experiments was obtained from those that
ntained potassium in addition to nitrogen:
K, and especially, NK. It seems to us that
e pronounced effect of potassium observed in
e experiments with wheat, which exceeds the
sitive effect of phosphorus, is attributable to
e deficiency of this element in the soils, and
its favorable effect on the utilization of the
trogenous fertilizer ammonium nitrate, more
ecisely its ammonium portion.

We should mention that, in the pot experi-
ents of virgin soil conducted in 1956-1957, a
pid depletion of the proportion of potassium
s observed (Table 9). Even in the second
ar of experiment the yield in containers with-
t K (as compared with NP) was extremely
w. The same pot experiments showed differences in the specific effect of potassium on elements of structure of the yields; adequate supply of potassium is expressed above all in the fullness of the kernel; the highest weight for 1000 kernels is found in the NK treatment.

Conclusions

1. In spite of the high fertility of newly cultivated sod, strongly podzolic soils of coarse texture, their response to mineral fertilizers is considerable, not less than the responsiveness of long-cultivated soils to fertilizers. The inadequate level of nitrogen supply in the newly cultivated soils is evident in the marked effect shown by nitrogenous fertilizers (NP, NK, NPK). Potassium fertilizers were very important for spring wheat in the soils studied: the highest

increases were obtained with fertilizers containing potassium (NK, NPK).

2. To obtain high yields and to maintain the fertility of newly cultivated soils, it is advisable to use mineral and organic fertilizers even for the first crop after grubbing.[2]

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[2] The work was done with the participation of V. M. Prudnikova, Assistant, and students of the Faculty of Agronomy.

ONTENT OF AVAILABLE PHOSPHATES IN CARBONATE SOILS F CENTRAL ASIA AND THE EFFECTIVENESS F PHOSPHOROUS FERTILIZERS IN IRRIGATED COTTON DISTRICTS

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It is very important for cotton yields to de- mine the total phosphorus in the soil needed supply the plants, to ascertain the degree of ailability of soil phosphates, and to establish effectiveness of phosphorous fertilizers in irrigated districts of Central Asia. The al phosphorous content of the soils in the ton districts of Central Asia varies from .0%-0.24% of the soil by weight. The differ- es in the phosphorous content depend con- lerably on the parent materials on which se soils were formed. Sierozems, together h chernozems and chestnut soils (5, 6, 9), among the soils richest in phosphorus. As go from the zone of typical sierozems to the ht and desert soils of Central Asia a trend ward a reduced total phosphorous content (3) observed. Within each zone the total phos- orous content also decreases as we go from rozems to bog-meadow soils.

In the practical use of phosphorous fertilizers s important to know the total content of phos- orus in the soil and the content of the avail- e form to plants. The overwhelming bulk of osphorus in the soils of Central Asia is in neral form (1, 2, 3).

We adopted the methods developed by Chiri- v (11) and Michigin (3) in investigating the ms of phosphorus in soils of Central Asia. using these methods in our chemical studies was possible to demonstrate very substantial ferences in the solubility of soil phosphates. we go from sierozems to meadow and bog- adow soils, a decrease in phosphorus solu- in acetic acid extracts and an increase in amount removed in hydrochloric acid ex- cts (1, 2, 3) is observed.

Our studies, carried out on typical sierozems d old-irrigated meadow soils, supported this sis (Table 1). It was demonstrated that the in content of phosphorus is removed from the l in the acetic acid extracts. The amounts of ganic phosphates in both soil types are relative- small and vary from 41-76 mg P_2O_5 per kg of soil.

The content of available phosphates in carbonate soils extracted with carbonic acid and ammonium carbonate is relatively small and constitutes only 2%-5% of the total phosphorus. Their content increases from the light sierozem to the meadow soils, but in the bog-meadow soils the content of phosphorus removed in both the ammonium carbonate and especially in the carbonic acid extracts drops off. The content of available phosphates in the different soils depends to a great extent on the system of applying phosphorous fertilizers.

Our laboratory and laboratory-field investigations from 1952-1958 showed that phosphorus added to the carbonate soil of Central Asia remains in them for a long time in a form available to plants.

In one of the field studies extending over a number of years, made on an old-irrigated, typical sierozem, when phosphorous fertilizers were added every year, we observed a gradual increase in the content of available phosphates in the plow layer of the soil (Table 2).

In the experimental treatment in which P_2O_5 was added every year at a rate of 110 kg/ha, the amount of available phosphorus increased from 22.0 mg/kg of soil (before the addition of fertilizer) to 55.5 mg P_2O_5/kg in the sixth year of the experiment. When phosphorous fertilizers were added every year at a rate of 40 kg P_2O_5/ha, the content of available phosphorus over the same period rose from 26.6 to 35.7 mg P_2O_5/kg of soil.

It is of interest to mention that after the experiment had run six years there was an increase in the soil not only of the available forms of phosphorus, removable with ammonium carbonate extracts, but also of the acid-soluble and consequently of the total phosphorus. Thus, for example, the quantity of phosphates removable in acetic-acid extracts with the addition of P_2O_5 at the rate of 110 kg/ha rose by 256 mg P_2O_5/kg of soil as compared with the control,

Table 1

Forms of phosphorus (after Chirikov) in various soils of Tashkent region, mg P_2O_5/kg of soil

Soils	Horizon, cm	Extracts				
		1% ammonium carbonate	carbonic acid	0.5 N acetic acid	0.5 N HCl	ammonia
Typical sierozem,	0—28	16	50	1122	110	73
Oktyabr'skiy district	28—40	8	33	975	108	44
Typical sierozem,	0—28	11	57	1281	152	54
Yangi-Yul' district	28—40	9	35	939	119	41
Meadow, old-irrigated,	0—28	29	52	1050	123	76
Yangi-Yul' district	28—40	10	37	985	108	47
Meadow, old-irrigated,	0—28	17	49	1025	119	58
Oktyabr'skiy district	28—40	11	33	975	110	44

Table 2

Accumulation of available phosphates in the soil with systematic application of phosphorous fertilizers, mg P_2O_5/kg of soil in ammonium carbonate extracts

Year experiment conducted	Without fertilizers	Added every year			
		Nitrogen	Nitrogen + phosphorus at a rate of kg P_2O_5/ha		
			20	40	110
1952	14.0	22.0	25.7	—	35.5
1953	18.7	22.5	25.0	—	37.5
1954	11.5	18.7	25.0	—	49.7
1955	14.1	18.9	20.6	26.6	49.7
1956	12.5	15.7	—	36.6	63.5
1957	16.6	17.6	22.6	35.7	55.5

and by 278.5 mg P_2O_5/kg of soil as compared with the addition of nitrogen fertilizers alone (Table 3).

Investigations of the All-Union Scientific Research Institute of Cotton Growing (SoyuzNIKhI) and the Tadzhik Scientific Research Institute of Agriculture demonstrated that the effectiveness of phosphorous fertilizers depends both on the genetic characteristics of the soils of the cotton-growing districts of Central Asia and on the content of available phosphorus in the soils.

From the data yielded by one-year and many-year field experimental studies on the effectiveness of phosphorous fertilizers in the different soils of Central Asia conducted between 1942 and 1957 (Table 4) it has been determined that the average (over 178 experiments) increased yield of raw cotton from the addition of phosphorus amounted to 3.2 cntr/ha against a background of nitrogen fertilization.

In spite of the high total phosphorous conte in the soils, the effectiveness of phosphorous fertilizers added to cotton is fairly high.

The highest increased yield of raw cotton (6.1 cntr/ha) is obtained from adding phospho ous fertilizers to irrigated sierozems of the Vakhsh River valley, and the least (1.6 cntr/h in the long-irrigated meadow soils of the Uzbe and Turkmen SSR's.

For two decades now, cotton and other cro of industrial importance have been intensively provided with mineral fertilizers (Tables 4 ar 5).

The ratio of nitrogen to phosphorus in the annual applications of fertilizers in the Uzbek SSR is approximately 1:1, and in the Tadzhik SSR, 1:0.7. The increased use of mineral fer tilizers in the cotton-growing districts of Cen tral Asia undoubtedly has had a favorable effect in increasing the cotton yields.

As investigations by the All-Union Scientifi Research Institute of Cotton Growing have sho the need of cotton for phosphorus (calculated a P_2O_5) is almost three times smaller than for nitrogen.

For a raw-cotton yield of 30 cntr/ha, 146 k of nitrogen and 47 kg of phosphorus are removed. Consequently, an amount of nitrogen added to cotton in the form of mineral fertiliz approximately equal to that removed in the ra cotton, while phosphorus is added in amounts that exceed its removal by two to three times.

In using phosphorous fertilizers it is ordin arily assumed that large amounts of phosphor have no toxic effect on the cotton plant.

Table 3

Forms of phosphorus (after Chirikov) in the soil after application of phosphorous fertilizers for six years

Added each year (1952-1957)	mg P_2O_5/kg of soil found in extracts					Total phosphorus, %
	ammon carbonate	$H_2O + CO_2$	$C_2H_4O_2$ 0.5 N	HCl 0.5 N	NH_4OH	
Control, no fertilizer	12.5	53.5	1144	106	66.5	0.209
No phosphorus, with basic amount of N	15.7	50.0	1122	110	72.9	0.209
Basic amount of N + 40 kg P_2O_5	36.5	60.0	1310	110	46.0	0.218
Basic amount of N + 110 kg P_2O_5	68.0	78.5	1400	100	71.2	0.233

Table 4

Added yield of raw cotton from the addition of phosphorous fertilizers to various soils of Central Asia. Experiments 1942-1957

Soil	No. of experiments	Incr. yields fr. phos. cntr/ha
Light sierozem	17	3.0
Typical sierozem	85	2.7
Dark sierozem	18	3.2
Meadow, old-irrigated Uzbek and Turkmen SSR's	23	1.7
Takyr	9	2.8
Old-irrigated sierozem Vakhsh valley	21	6.1
Sierozems and meadow soils of Gissarskaya valley	5	3.1

Table 5

Application of mineral fertilizers to cotton and yield of raw cotton in the Uzbek and Tadzhik SSR's in 1957

Republic	Nutrients applied, kg/ha			Yield of raw cotton, cntr/ha
	N	P_2O_5	K_2O	
Uzbek	100	98	7	20.2
Tadzhik	185	130	4	26.3

In pot experiments with large amounts of superphosphate added, Chumanov (10) observed no harmful effect on cotton seedlings. But further investigations showed that excessive application of phosphorous to cotton in both the early and the later periods of development had a profound effect on the biochemical processes taking place in the plants and on the growth and development of the plants.

According to data collected by Sabinin and coworkers from pot cotton experiments using typical sierozem, the most favorable ratio of nitrogen to phosphorus was 1:0.5. Increasing the amount of phosphorus to 1:1 or 1:1.5 led to decreased utilization of the phosphorous fertilizers, delay in development, and reduced yield of raw cotton. Sabinin also notes that a liberal amount of phosphorus increases the dry weight of the leaves but at the same time shortens their life cycle. Michigin demonstrated that an excessive amount of phosphorus added to cotton appreciably increases its phosphorous content (especially in the mineral form), but at the same time it reduces the uptake of nitrogen by the plant. Reduction in nitrogen utilization by cotton with excessive application of phosphorus was also noticed in field experiments conducted by us in 1954-1957 (12, 13, 14).

In analyzing the results of our investigations we considered it necessary to generalize the data of the field experiments on the effectiveness of phosphorous fertilizers on soils with different contents of available phosphates. We conducted these experiments in 1954-1957 under the conditions of Central Asia and southern Kazakhstan (Table 6). From the data presented it appears that there are some general principles governing the response to phosphorous fertilizers of the light sierozems of South Kazakhstan region, the typical sierozems of the Uzbek SSR, the meadow and sierozem-meadow soils of the Uzbek SSR and the Gissarskaya valley of the Tadzhik SSR. The following principles apply to these soils: a) for soils with a content of available phosphorus equal to 18-28 mg P_2O_5/kg of soil, the addition of phosphorous fertilizers increases the yield of raw cotton by 2.7-4.6 cntr/ha as compared with the addition of nitrogen fertilizers alone; b) for soils with a content of available phosphorus equal to 30-45 mg P_2O_5, the addition of phosphorous fertilizer at the rate of 45-60 kg/ha increases the yield of raw cotton by 2.7-4.4 cntr/ha; increasing the rate of phosphorus to 70-120 kg P_2O_5/ha not only does not result in a further increase in the yield of raw cotton, but a reduction of fertility as compared with the addition of phosphorus at a rate of 45-60 kg P_2O_5/ha is observed; c) for soils with a content of available phosphorus equal to 50-60 mg P_2O_5/ha or higher, the use of phosphorous fertilizers, as a rule, leads to a reduction in the yield of raw cotton.

The old-irrigated sierozems and sierozem-meadow soils of the Vakhsh valley in the Tadzhik SSR differ from the other soil groups of Central Asia in their response to the addition of phosphorous fertilizers and in the influence of the available-phosphate content on the effectiveness of these fertilizers. The highest increase yield of raw cotton from the addition of phosphorus, reaching 7.6-10.0 cntr/ha, is achieved where these soils have an available phosphorous content equal to about 8-15 mg P_2O_5/kg of soil. Where the available phosphorous content equalled 16-25 mg P_2O_5/kg of soil, the addition of phosphorus at a rate of 30 kg P_2O_5/ha increased the yield of raw cotton in the experiments by 3.1 cntr/ha as compared with the addition of nitrogen fertilizers alone. Raising the amount

Table 6

Effectiveness of phosphorous fertilizers and rates of application to soils with different contents of available phosphates under the conditions of Central Asia and southern Kazakhstan. Experiments 1954-1957.

Soil	Avail. phos. in the soil, mg P_2O_5/kg of soil, ammon. carbonate extract	No. of experiments	Increased yield of raw cotton, cntr/ha from the addition of phosphorous fertilizers (with basic amount of N[a]) P_2O_5 kg/ha			
			30–45	50–60	70–90	100–120
Light and typical sierozem, old-irrigated, Uzbek and Tadzhik SSR's	18—28	10	4.6	—	3.8	—
	30—40	8	3.3	4.4	—	3.2
	50—60	13	—2.4	— 1.9	—	—2.7
Old-irrigated meadow soils, Uzbek and Tadzhik SSR's	18—28	4	—	2.7	—	3.0
	30—45	12	2.7	3.4	3.0	1.9
	55—60	5	—1.2	— 1.6	—	—2.2
Old-irrigated sierozem and sierozem-meadow soils, Vakhsh valley, Tadzhik SSR	8—15	6	7.6	10.0	10.0	8.3
	16—25	4	3.1	2.1	1.7	1.0
	26—38	5	0.7	— 0.2	—1.3	—0.4

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[a] Nitrogenous fertilizers were added in the form of ammonium nitrate at a rate of 90-150 kg/ha; N — depending on cultivated land.

ophosphorus above 50-70 kg P_2O_5/ha led to ne reduction of the yield of raw cotton.

In soils containing 26-38 mg P_2O_5/kg, phos- orous fertilizers did not increase the yield raw cotton, regardless of the rate of use, cording to the averaged results of five exper- ents.

From the data given it follows that the ex- me indications set forth previously for es- lishing the soil requirement for phosphorous tilizers may not be required for all soil tricts and zones of the irrigated regions of ntral Asia and southern Kazakhstan. The gree of the soil's need for phosphorous fer- zers should be determined for each soil gion on the basis of experimental investiga- ns.

In order to establish the degree of soil sat- ation with available phosphate, chemical dies were made in 1956-1958 on the soils areas where phosphorous fertilizers were ed intensively.

Of 17,127 ha investigated in the Uzbek and dzhik SSR's 59.2% of the area contained up to mg P_2O_5/kg of soil; 30.7% of the area, from -60 mg P_2O_5; and 10.1% of the area had an ailable phosphorous content above 60 mg O_5/kg of soil. If we accept our data as aracterizing the average values for the ailable phosphorous content in the soils of kolkhozes and sovkhozes, then of the total ea seeded to cotton in the Uzbek and Tadzhik R's (about 1.5 million ha), 150 thousand ha ntain more than 60 mg P_2O_5/kg of soil. Con- quently, it is necessary to take immediate ps to organize chemical studies of the irri- ted soils of Central Asia to work out the oper use of phosphorous fertilizers accord- to the content of available phosphates in soil.

As our investigations showed, in the compil- on of soil charts for the available phosphorous ntent in soil from each hectare of the crops, is necessary to take from one to four sam- s, depending on the method of collection of soil samples. In taking the soil samples, each irrigated tract it is necessary to parate areas adjacent to roads, reservoirs, d other natural boundaries of the tract. In mpiling soil charts for phosphorus it is ex- dient to group the soil by level of available osphorus in the following series:

Group	Content of available phosphorus (ammonium carbonate extracts), mg P_2O_5/kg of soil
I	5-15
II	16-30
III	31-45
IV	46-[60]
V	above 60

The separation of soils into groups according to available phosphorous content is required for effective use of phosphorous fertilizers and for establishing the rates of application for different soils. This grouping of soils will answer to a large extent the requirements set for the proper application of phosphorous fertilizers to cotton.

Conclusions

1. The soils of the cotton-growing districts of Central Asia are relatively rich in phosphorus (0.10%-0.24% total phosphorus). The overwhelming preponderance of phosphorus in the soil is in the mineral form. The content of organic phosphorus, depending on the soil group, varies from 10% to 30% more of the total phosphorus. The smallest quantity of organic phosphorus is contained in the old-irrigated sierozem and sierozem-meadow soil of the Vakhsh River valley in the Tadzhik SSR.

2. The content of available phosphates soluble in ammonium carbonate and carbonic acid extracts depends to an appreciable extent on the rate of application of phosphate fertilizers and the duration of their use.

3. In the carbonate soils of Central Asia the applied phosphorus remains in the soil for a long time in a form available to plants.

4. The genetic peculiarities of the different soils determine the effectiveness of phosphorous fertilizers to some extent. The highest additional yield of raw cotton from the use of phosphates is observed in the soils of the Vakhsh River valley in the Tadzhik SSR, and the lowest, in the meadow soils of the Uzbek and Turkmen SSR's.

5. The effectiveness of phosphorous fertilizers depends to an appreciable extent on the content of available phosphorus in the soil. In this regard, the proper use of phosphorous fertilizers permits some of the fertilizer to be released for other agricultural crops.

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HANGES IN THE PERCOLATION)F SALINE SOILS DURING LEACHING

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evelopment

Soil moisture movement has long been an bject of study, and a series of detailed investiations on it (2, 5, 6 and others) has been pubshed. However the forms and movement of oil moisture are investigated principally in onsaline soils, and little attention is paid to the ffect of salts on the water movement in the orous soil medium. This has great practical alue for southern soils requiring leaching.

This article is devoted to the question of ercolation and the gravitational flow of water n the leaching layer of a saline soil.

The percolation investigation was carried out n special soil monoliths (diameter 71 cm, eight 110 cm). These were excavated and awed with a cylindrical hand saw, then coated ith clay and enclosed in a metal collar of the ame diameter. Observations were made while eaching salts from the soils by means of autoatic application of water to the surface of the onolith. Such an arrangement allowed leaching o be conducted under field conditions without evering the monoliths from the underlying horions; at the same time lateral flow from the esignated leaching area was avoided and maxium approximation of the experiment to natural onditions permitted.

Concurrently studies were made in filled olumns (diameter 5-6 cm, height 20-100 cm) nclosed in sections of glass tube (20 cm) which ere joined by rubber bands. Before loading, e sample of saline clay soil was passed through sieve with a 5 mm opening. In one series of xperiments water was automatically added to e surface from inverted bottles; in the other eries it was added in measured quantities after e complete cessation of drainage. Each time fter total water discharge four columns and eir supports were weighed before a new irriation. Change in the water-holding capacity of e soil was measured by the weight change.

Before leaching, the amount and composition f the salts in the monoliths were determined and the physical properties relating to water were studied in three replicate samples. One of the horizons was used to load the columns. Twenty columns and 87 monoliths located at 53 Shirvanskaya steppe locations in Azerbaydzhan were studied.

The rate of water intake on the field monoliths was studied under convenient conditions during periods of from 6-8 hours to 5-10 days.

The theory of the process of water intake from the soil surface is well known from the works of Kostyakov (4), Kachinskiy (3), Tsiplenkin (8), Volobuyev (1) and others; its rate is described by a declining curve of parabolic form. The results of our observations confirmed this. The initial very large water intake velocity corresponds to the process of filling the large crevices and pores. The final, low rate of intake corresponds to the process of slow suction of the water into fine crevices and soil capillaries. Under natural conditions both processes proceed simultaneously, but the first predominates in the beginning, the second at the end of irrigation.

Sodium sulfate clay solonchak distributed in inter-fan depressions, along the loops of Turianch and Geokchay River alluvial fans and also around the periphery of the Karasu swamp possess low water intake rates. After their large crevices and pores are filled, the water intake practically stops and the intake rate curve merges with the x-axis.

Percolation was observed in the filled columns with the constant pressure head of a 5 cm water, and with periodic irrigation. In the first case the percolation rate was observed, in the second the intensity and duration of gravitational water and also the removal of salts.

With a constant water layer above the soil, the rate of percolation through the 80 cm filled columns, as in the field monoliths, varied as a declining curve (Fig. 1, column 13).

Table 1

Duration of gravitational water drainage, days

Column No.	Leaching No.	Duration of gravitational water drainage, days	Change of mineral content in percolate, g
14	1	24	263 201
	2	17*	173 149
	3	49	122
5	1	31	167
	2	11*	105
	3	49	66
	4	94	29

* Incomplete

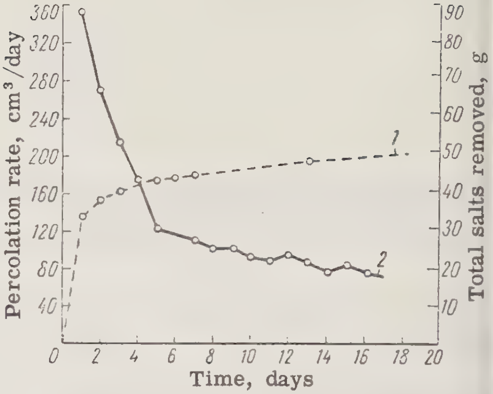

Fig. 1. - Change in intake rate during the leaching process (column 13).

1 - Total salts removed, g; 2 - V = cm^3/day.

Determinations of the mineral content of the filtrate showed that the percolation rate through the columns decreases as salts are removed from the soil. In the first day of leaching, 360 cm^3/day passed through the column; after three days it decreased by a factor of three, and on the seventeenth day it had gone down to 72 cm^3/day, or by a factor of five. During this time the total salt content in the column decreased from 74.8-25.0 g.

When adding leaching water to the column surface in fractional portions, a sharp increase in the time required for complete drainage of gravitational water was observed towards the end of the experiment. In column 14, filled with sulfate-chloride clay solonchak, the duration of gravitational flow increased from the first to the third leaching from 24-49 days. In the sodium-sulfate clay of column 5 the duration of gravitational water drainage increased from 31-94 days from the first to fourth leaching. In both cases the leaching operations were carried out in the laboratory with air temperature 25°-30° C and the column surface was not protected from evaporation (Table 1).

The increase in drainage time for the gravitational water was also accompanied by the removal of salts and a lowering of the mineral content of the filtrate: in column 14, from 263-122 g/l, in column 5 from 167-29 g/l.

The continuous drainage of gravitational water is connected with the diffusion of salt to its channels. First, the water drained from the large pores and capillaries; therefore the salts were leached from them more quickly and the solution concentration in them was reduced.

It is known from the works of Trofimov (7), Dolgov (2) and Rode (6) that the lower the concentration of the soil solution, the more loosel bound water there is in the soil. Consequently when the soil is being leached, a layer of loosely-bound water first forms on the walls o the large pores from which the salts have been leached. The fine pores and interior of the soil aggregates are leached with greater difficulty, and their solution concentration remains high. As a result of the different concentratio of salts at numerous points of the soil, mediu diffusion potentials arise and the diffusion of salts to the leached portions of the soil begin, i.e. to the gravitational water channels.

The flow of salts to the leached portions is accompanied by an increased concentration of their soil solution and a diminution of the loosely-bound layer of water; this changes into gravitational water and drains from the column As salts are leached from the soil the diffusion potential goes down and the process of equalizing the concentration of the solution in the leaching soil layer slows down. This explains the lengthening of the gravitational water drainage period towards the end of leaching.

The investigations performed permit us to conclude that leaching salts from soils is accompanied by an increase in their water-holdin capacity and a decreasing of percolation.

To check the increase in water held by the soil during leachings, three filled columns wer examined. The moisture increment was determined by weighing the columns before each leaching, and the amount of leached salts (in th filtrate) was found. The resulting indices are

Table 2

Texture, salinization and moisture of soils

Column No.	Wt. of dry soil in column, g	Soil moisture in wt. percentages	% of particles		Soil salinization, %	
			< 0.001 mm in diam.	< 0.01 mm in diam.	solid residue	chloride
10	1217	8.5	35.8	72.4	3.084	0.071
11	1015	12.7	47.0	89.2	4.240	1.154
12	1011	11.1	31.2	77.1	3.328	1.367

resented in Table 2.

The results of the experiment (Table 3) show hat during leaching the amount of salts in the olumns decreases and the water-holding capac- y of the soil simultaneously increases. At the eginning of the leaching these two different rocesses occur in a definite quantitative rela- ionship: as more salts are leached from the oil, more moisture is added to it. As the amount of water that has percolated increases and the total salt content in the column decreases, the intensity of their leaching is reduced and the moisture increment in the soil is lowered in a parallel manner.

In soils of chloride and mixed chloride-sulfate salt composition the moisture increment corresponds to the quantity of salts removed; in sodium-sulfate soils the moisture gain is

Table 3

Removal of salts and change of total moisture content in filled soil columns during leaching

Leaching No.	Columns								
	10			11			12		
	Percolate, cm³	Salts removed, g	Moisture increment, g	Percolate, cm³	Salts rem., g	Moisture increment, g	Percolate, cm³	Salts rem., g	Moisture increment, g
1	14	2,86	not det.	66	15.18	not determined	16	8,29	not det.
2	14	2,86	8.86	31	5.52		44	7.70	6.70
3	12	2.16	9.66	47	3.76	3.76	43	5,06	7,06
4	8	1.44	3.94	47	2.96	2.96	47	3,23	4,23
5	36	4.71	4.71	47	1.97	1.97	43	2.11	3,11
6	42	3,46	4,46	48	1.37	4.37	48	1.59	0,41
7	44	2,44	3.44	48	1.16	3.66	48	1.00	0,50
8	47	1.78	2.28	49	0,47	0.97	48	0.80	0.30
9	45	1,38	2.38	48	0.55	1.05	47	0.87	2.87
10	47	1.33	1,83	47	0.57	1.57	47	0.90	0.40
11	48	0.90	2.90	47	0.44	0.44	46	0.73	2.73
12	48	0.90	1.90	48	0 45	0,45	45	0.61	2.11
13	45	0.79	3.79	48	0,69	1.69	38	0.50	—5.0
14	48	0.73	0.73	48	0.51	0.01	28	0.37	+3.87
15	43	0,56	6.16	49	0.52	1.02	43	0.57	2,07
16	48	0.56	0.56	50	0.65	—0.35	48	0.50	0.00
17	50	0.81	—0.19	49	0.40	—1.60	—	—	—
18	47	0,57	1,07	51	0.30	—0.70	—	—	—
19	37	0,34	—0.16	47	0.35	+1.35	—	—	—
20	—	—	—	49	0.34	1.34	—	—	—
21	—	—	—	46	0 32	2.82	—	—	—
22	—	—	—	50	0.35	0.35	—	—	—
Total	723	30.60	58.3	1060	38.79	26.9	680	34—80	31.70

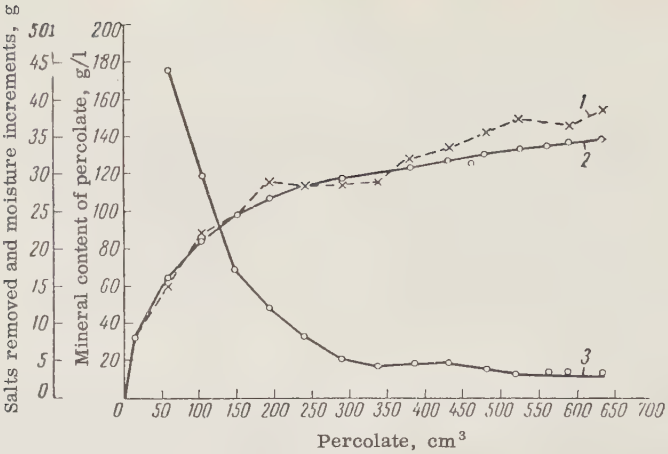

Fig. 2. - Relationship of total moisture increment and amount of leached salts with quantity of water percolated through a chloride-salinized soil column (column 12).

1 - water, g; 2 - salts, g; 3 - mineral content of percolate, g/l.

twice as large as the total amount of leached salts. In the first case the salts are replaced by water in the ratio of 1:1 and in the second with a 1:2 ratio (Figs. 2, 3).

The increase in water-holding capacity was detected also under natural conditions: in soils of undisturbed structure. In solonchak containing 3.58% salts and 1.27% chloride after leachi at the rate of 2050 m³/ha, the field moisture capacity in the 0-50 cm layer was ascertained to be 30.6%, and after leaching at the rate of 3040 m³/ha, 33.8%. In the first case, 74.8 metric tons/ha of salts were removed and the gain in moisture over the initial condition in the same layer was 402 m³/ha. In the second case

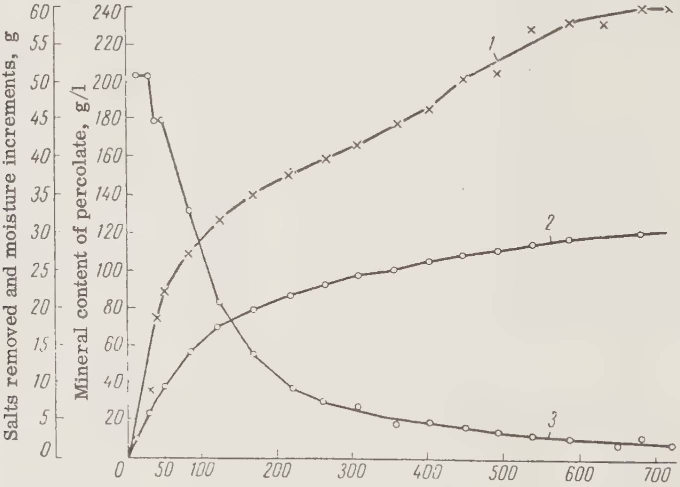

Fig. 3. - Relationship of total moisture increment and amount of salts removed with quantity of water percolated through a sulfate-salinized soil column (column 10).

1 - water, g; 2 - salts, g; 3 - mineral content of percolate, g/l.

85.3 metric tons/ha were removed and the moisture increment reached 689 m³/ha, i.e. 287 m³/ha more.

Conclusions

1. Observations made of the water intake rate on field monoliths and filled columns and also reports from the literature show that the percolation through the leaching layer of a saline clay soil proceeds with diminishing velocity. When water is periodically applied to the saline soil surface, the gravitational moisture at the beginning of leaching completely drains in 24-31 days; with succeeding leachings the gravitational flow lasts 49-94 days. The percolation rate decreases and the drainage period for the gravitational water lengthens more and more markedly as salts are leached from the soil.

2. The change in percolation takes place depending on the change in water-holding capacity of the saline soil. The experiments showed that the water-holding capacity of soil is not a constant quantity: during desalinization, the more salt is removed from the soil the more it increases.

3. The leaching of saline soils is accompanied by a decrease in concentration of the soil solution and an increase in the amount of loosely-bound water; this covers the soil particles in the form of a film, clogs the fine pores and constricts the water-conducting ones, at the same time increasing the water-holding capacity of the soil and decreasing its percolation.

4. During the leaching of saline soils initially, as is well known, salts are leached from the upper soil horizons. These first lower the percolation rate which slows down the leaching of the lower-lying soil layers and underlying parent materials. Therefore, after leaching the upper horizons it is advisable to plow deeply and improve the percolation of the soils.

5. The demonstrated continuous drainage of gravitational moisture shows that when sowing crops on insufficiently leached saline soils it is expedient to irrigate at an increased rate which exceeds the moisture deficit of the root zone. The excess water will drain and carry away salts into the lower layers of parent materials, into the ground waters and into drains.

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THE SIXTH (TEHERAN) SYMPOSIUM OF UNESCO ON THE PROBLEM OF SOIL AND WATER SALINIZATION[1]

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The United Nations Educational, Scientific and Cultural Organization (UNESCO) is a permanent Advisory Board founded in 1951 for the study of arid zones. It is composed of 10 members selected from a group of scientists and engineers who are familiar with problems associated with arid and semi-arid regions. Within the circle of specialists the Board is known as the "Arid Committee."

Since 1952, the Advisory Board on arid countries has held six scientific conferences on the following problems:

1. Hydrology and hydrogeology of arid countries — in 1952 at Ankara (Turkey).

2. Ecology of arid zone plants — in 1954 at Montpellier (France).

3. Solar and wind energy and ways of using them in arid districts — in 1955 at New Delhi (India).

4. Climatology and microclimatology — in 1956 at Canberra (Australia).

5. Soil erosion in arid districts — in 1957 at Karachi (Pakistan).

6. Saline soils and water — in 1958 at Teheran (Iran).

This last conference took place October 11-15, 1958 at Teheran University and was devoted to four important problems: 1) hydrology of saline water; 2) physiology of crops developed on saline soils and irrigated by mineralized water; 3) use of saline soils and salt water in agriculture (soils, water, and crops); 4) distillation of salt water (methods and apparatus).

Sixty members were officially invited to the Teheran Symposium; 20 were invited by the Iranian Government and 22 by UNESCO with the remaining 18 detailed by their respective governments or by their separate scientific institutes. Scientists of the following countries were represented at the Symposium: Iran, India, Australia, Pakistan, Turkey, United Arab Republic, Iraq, England, South Africa, U. S. A., U. S. S. R., France, Holland, Italy, Belgium, Morocco, and Tunisia. A total of eight members participated from the Soviet Union. These were: Corresponding member of the Academy of Sciences, U. S. S. R., V. A. Kovda; Professor G. V. Bogomolov; Professor P. A. Genkel'; Professor O. S. Lenchevskiy; Academician of the Academy of Sciences, Tadzhik SSR, I. N. Antipov-Karatayev; Professor A. N. Rozanov; Candidate of Science, A. A. Kizilova; Post-Graduate of the Academy of Sciences, Uzbek SSR, Nariman Khodzhibayev.

One-hundred twenty reports were presented, 15 by Soviet scientists. Fifty-two reports were read at the Symposium, five by Soviet delegates. In addition, three reports presented by Soviet delegates at the close of the Symposium[2] (those by I. N. Antipov-Karatayev, A. N. Rozanov, and A. A. Kizilova) were read at a separate meeting of specialists in Iran called by the Irrigation Body (the country's irrigation administration).

Three additional reports were given by Soviet scientists in a seminar at the Soil Laboratory of the Irrigation Body. All of the reports presented by U. S. S. R. scientists were received with great interest.

Scientific Results of the Symposium

We shall begin the review of the Symposium by turning first to the hydrological and hydrogeological reports. It is natural that the water problem for the arid districts should be the ost important; therefore, it is understandable at this problem has served and will continue serve in one form or another as the subject many reports and generalizations at all the mposiums of UNESCO.

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[1] Presented at the joint session of the II and VI committees of the All-Union Society of Soil Scientists, December 12, 1958.

[2] These members arrived in Teheran late for reasons beyond their control.

The reports and generalizations made on is problem at the Teheran Symposium were sically concerned with explaining the causes d nature of mineralization principally of ound waters in arid countries. From the tal number of reports we present the following ite voluminous ones by Soviet authors:

1. G. V. Bogomolov. Conditions required r the formation of fresh water in certain des- t zones of North Africa, U. S. S. R., and utheast Asia (the report was read by the thor).

2. S. Silin-Bekchurin. Conditions required r the formation of mineralized water in the id zone.[3] Here we should also mention:

3. The report by F. Dixey (Great Britain). drology as it relates to salinity. This report is viewed as an introduction to the problem of ter; thus it bore a rather program character. the report were examined 1) the role of pre- pitation in bringing salts onto deserts and dry eppes (up to 2 kg/ha in the Kalakhara Desert, out 1 kg/ha in Iran and Iraq, 0.5 kg/ha in the bi Desert); 2) the role of rock lithology in ter salinization; 3) the need of studying ound waters and their seasonal dynamics; the possibilities of soil salinization and solon- ization during irrigation by mineralized waters; d 5) methods for distilling salt water.

4. L. I. Tison (Belgium). Hydrology and linization of ground waters. In the report are amined the transformation patterns of the ters' salt composition (formation) by degree infiltration into the ground; at the same time, e zone has been distinguished where the role exchangeable reactions is greatest in the insformation of the waters' chemical composi- n; special attention has been devoted to salt ter formation during infiltration of marine ters.

5. Kh. Scholler (France, Bordeaux). An erpretation of the chemical analyses of salt ter. Proceeding from an idea of the zonality the chemical composition of both surface and ound waters based on climatic, geological thological) reasons, the author proposes ysicochemical computation methods for pro- ssing hydrochemical analysis data for pur- ses of determining both the nature of min- alization and the factors which have caused e formation of water salinization types.

A series of reports were of regional character and present concrete data for the following generalizations. Here we are concerned with:

6. I. K. Jain (India). The hydrological aspect of salinity in agronomy.

7. D. I. Burdon and S. Mazlum (Syria). Several chemical types of ground waters in Syria. In the report data is presented on the chemical analysis of 781 samples of ground waters in the districts of Syria situated west of the Euphrates River (the analyses were made at four different laboratories: Riverside, Rome, Amman, and Damascus). The waters were grouped according to the predominant cation and anion chemical composition. The following groups of examined ground waters (expressed in percent of the total number of studied samples in Table 1) were distinguished according to the predominance of cations and anions (>25% of a given cation from the total meq).

Table 1

Dominant salt (> 25%)	HCO_3^-	$SO_4^{=}$	Cl^-	Mixed salinization	Total of samples
Ca	31.4	4.3	2.9	0.0	38.6
Mg	0.0	2.8	0.0	4.3	7.1
Na	4.3	1.4	14.3	0.0	20.0
Mixed salinization	12.9	4.3	5.7	11.4	34.3
Total	48.6	12.8	22.9	15.7	100.0

The dependence of mineralization of the waters under study upon the lithological composition of water-bearing rocks has been determined: the calcium bicarbonate waters are associated chiefly with basalt outcrops, and the magnesian waters (there are few in Syria) with dolomite outcrops. Based on the degree of mineralization the ground waters are characterized by a relatively low salt content -- of an order of 2 g/l. The mineralization seldom attains 5-13 g/l.

8. Kh. Huber (Iran). The influence of geological conditions on the mineralization of water in the Zam-Rud District.

9. I. Tavana (Iran). The geochemistry of ground waters of the Gum District.

10. A. I. Bakker (Iran). River flow in Iran.

In Iran the hydrographic service in the last

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[3] Because of the anticipated publication of these and er reports in Russian, we shall not discuss them.

2-3 years has expanded the permanent system to 130 points. The observation schedule includes suspension and water flow, evaporation and the snow cover. Eight numbers of the "Hydrographic Yearbook" (2) have already been published from earlier data.[4] The last issue, No. 8, was published in 1957. The report by Bakker (FAO hydrology expert) makes generalizations of the data available on river discharge (run-off) in Iran. He proposes regionalizing the country by a hydrographic net.

11. Before the opening of the Symposium on salinized soils and waters, Professor Esmail Feylessoufi published a short article on ground waters, canals (underground water conduits with wells), and deep drill holes in Iran (3). With regard to what has been said previously concerning hydrological and hydrogeological studies in Iran, of great interest is the question of the underground water conduit method of harnessing and using ground waters in Iran, whose people, still at the very dawn of irrigation farming, have worked out this method. Thus, it is no wonder that Iran has become outstanding by its conduit method of using ground waters for irrigating fields. As mentioned previously, the start of conduit construction goes back to the beginning of the Islam era which can be seen by reference to conduits in the book by Nasera Khosrou: "Book of Travels." The exact number of conduit systems in Iran is at present unknown. From information gathered by Professor Feylessoufi their number totals 30, 000 of which 8, 000 are inoperative (dried up). Of a total of 50, 000 inhabited stations in Iran, 18, 000 employ the conduit method of irrigation. The total water consumption in all the conduit systems amounts to about 560 m^3/sec. By properly using even the existing conduit systems it is considered possible to increase the total water consumption to 1600 m^3/sec, which, in Feylessoufi's opinion, is three-fourths of the mean annual water consumption of the Nile around Cairo.

The general program of the Advisory Board of UNESCO is directed toward developing ways to increase water reserves in the arid countries for all-round use. Besides the hydrological and hydrogeological means mentioned previously, scientific institutions in many countries, which are being coordinated by UNESCO, are working on the problem of artificial rainfall. However, the greatest problem is still the development of an economically sound method for the removal of salt from marine waters, salt ground waters, and also from salt lacustrine waters. This is a problem for the future because many deserts of the world border on sea coasts. Studies of various countries in this field show that the presently existing distilleries permit us to obtain distilled water approximately 2-1/2 times more than the maximum actual cost of irrigation water obtained by the usual methods. There exist large distilleries which employ a multiphase process of distillation, yielding millions of gallons[5] of distille sea water per day.[6]

Further research is now being directed towards working out cheaper methods of removing salt from salt water. At the Teheran Symposium, reports by representatives of differen countries on this problem occupied a large place. Ten reports were presented on this problem:

1. By the time the Symposium opened, a voluminous (40-page) survey of institutes had been prepared which dealt with the problems of distilling salt water. This summary was prepared by UNESCO based on 14 specific problems which covered the various aspects of eac problem.

2. A second survey was made in the report by D. Nevile-Jones (Great Britain) on the successes of the United Kingdom in demineralizin salt water.

3. D.S. Jenkins (U.S.A.) also presented a summary report entitled "Fresh Water for Arid Countries."

In all three reports a comparative description of five types of methods was presented fo distilling water: 1) distillation by thermal an mechanical means, 2) solar distillation, 3) me brane processes, 4) freezing, 5) ion exchange and other methods: biological, extraction. Attention is directed to those countries where th greatest successes have been achieved in appl ing one or another method of distilling water. Finally, Jenkins gives a comparative table (Table 2) showing the cost involved in purifying water by one or another method.

4. E.D. Howe has also reported on the co parative cost of distilling water by various means.

From all these data we see that perfected methods for distilling water enable us to pose a practical question as to the possibility and expediency of using these methods for obtainin water for field irrigation. As Jenkins pointed out in his report, quite large-scale experimen of this type are already being conducted in Ca fornia and Texas.

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[4] Observations of some rivers have been made covering a period of 60 years, but such data are very small.

[5] A gallon equals about 4.5 liter.

[6] For example, a triple-phase distillery with an o put of 700, 000 gallons per day was constructed for Kuwait oil fields in 1949.

Table 2

Comparative table of the cost of 1,000 gallons of distilled water by years

Water Purification Method	1952		1957		1960-1970	
	Marine water, 35 g/l.	Salt water, 5 g/l.	Marine water, 35 g/l.	Salt water, 5 g/l.	Marine water, 35 g/l.	Salt water, 5 g/l.
Distillation (and solar)	2–5 dollars	2–5 dollars	1–3 dollars	1-3 dollars	Less 0.5 dollars	Less 0.5 dollars
Membrane	–	–	6	0.8 dollars	1 dollar	0.25 dollar
Freezing	–	–	–	–	0.5 "	0.50 "
Other Methods	–	–	–	–	0.5 "	0.25 "

Individual methods for distilling salt water have been examined in the other reports.

5. I. Hamaker (Netherlands). Development of a method of electrodialysis in Holland and in other affiliated countries.

6. B.A. Cooke, O.B. Volkman and I.R. Wilson (South Africa). An apparatus for the electrodialysis of salt water.

7. The Soviet delegate O.S. Lenchevskiy presented a report on methods of demineralizing and distilling water in the U.S.S.R.

8. R. Ambraggi. Studies in Morocco on the demineralization of salt water by solar distillation. The report describes two apparatus successfully being tried out in Morocco and called the "Morocco" and "Algeria."

9. G. Nebbia (Italy). Experiments with a vertical solar apparatus.

10. V.A. Badger (Michigan, U.S.A.). Fresh water from marine water by multiphase distillation.

The possibility of using saline soil and salt water, often peculiar to the arid regions, for crop cultivation is also associated with selecting salt-tolerance crops. Much attention was paid to this possibility at the Teheran Symposium which we can see from the following data. Reports on the physiology of salt tolerant plants constituted the first group of reports. Here we shall mention the following reports:

1. G. Repp (Australia). Basic ideas on the salt tolerance of plants. Mrs. Repp spent several years in Europe, the Sahara Desert and in Utah ascertaining the salt tolerant mechanism of halophytes as well as agricultural crops. She studied morphological features of adapting crops to salt. Characteristic of the physiological indicators are: a) the weak permeability of salt solutions into the cell — a defense against an outside salt attack; b) the tolerance of protoplasm to salt — a very important indicator of the salt tolerance of crops; c) growth of the succulence of glycophytes on saline soils.

In experiments with a number of natural crops on saline media we note a lowering of the osmotic adaptation, which leads to a lowering of the water intake in crops; this can be seen from the following data.

	Salt content in the root zone, in %	Maximum osmotic pressure in the atmosphere
Alopecurus pratensis	0.19	22.1
	0.35	16.2
Beckmania cruciformis	0.09	24.1
	0.61	19.4
Poa pratensis	0.09	26.2
	0.61	18.1

The field method of evaluating the salt tolerance of crops was proposed by the Salinity Laboratory at Riverside (U.S.A.) and consisted of setting up experiments by irrigating soils with experimental crops using different standards of artificially salinized water (15 g in a liter of NaCl and $CaCl_2$ in equivalent proportions). The amount of decrease in crop yield and productive capacity is a criterion of salt tolerance or the absence of salt tolerance.

The author suggests a physiological method as follows: small pieces of tissue from the lower part of the plant stem are immersed in solutions of NaCl of varying molarity; 24 hours later these pieces are transferred into weak hypertonic solutions of glucose and after 3-4 hours the phenomenon of plasmolysis is observed. It is best to compare the various species and kinds of plants simultaneously. Repp's report provided us with a comparative table for the agricultural crops of various countries.

2. P.A. Genkel' and V.P. Strogonov.

The physiology of crops on saline soils. The basic ideas of this report are known to the Soviet reader from data published in Russian and so a detailed review of this report is not given here.

3. H. Walter (FRG). Adaptation of crops to saline soils. The author divides the halophytes with respect to salt into three well-known groups: 1) excretion type; 2) regulation type; 3) accumulation type. Of interest are studies of the problem of crop succulence (Salicornia) dependence upon the concentration and quality of salt. Succulence is expressed in figures which determine the ratio of the water content to the amount of leaf surface. It was shown that, as the concentration of chlorides (sodium, potassium, magnesium and calcium) increased from 0 to 0.7 molarity, a rise of the succulence index took place; the succulence index of sulphates and nitrates did not change. A correlation between succulence and salt content in the cell sap of crops in the Namib Desert was found, which in its turn is associated with the salt content in soils.

4. M. M. Elgabaly (Egypt). Studies of the salt tolerance of crops and of the specific action of ions. In the report data is given from field studies on the salt tolerance of barley, wheat, clover, and beans. The sodium ions were accumulated in greater quantity by barley than by the other crops. The percentage of Ca and Mg in clover and in horsebeans (Windsor beans) turned out to be higher than in barley and wheat.

Elgabaly examines also the problem of the relationship of crops to exchangeable ions. It has been shown that the basic ion is better absorbed by the plant from two ion systems than from a single ion system. Thus, the Na^+ are more absorbed from the Na-Ca system than from the Na system. There is a dependence on the nature of the accompanying ion. Thus, the sodium ion is better absorbed from the Na-Ca system than from the Na-Mg system. This is explained on the strength of the Donnan's equilibrium equation.

Reports of a concrete experimental character were then presented.

5. A. Wahhab (Pakistan). Salt tolerance of different agricultural crops in the seedling stage.

In greenhouse experiments with 25 soils whose samples had been artificially salinized by NaCl in varying degrees (0.1%-0.6%), the germination capacity of the crops was analyzed. The degree of moisture in the experiments varied (15%-90% of the saturation moisture capacity). Twenty days after sowing germination was determined. The following crops were analyzed: wheat, corn, barley, cereal grass, rice and cotton. The toxic thresholds were found to be different for the crops under study.

6. P. Simmoneu (France). On halophytic vegetation.

In the report are described the halophytic crops which grow under different conditions in Algeria and in the Sahara.

Irrigation of the saline soils in the Sahara leads to a change of the natural saltwort vegetation to Aeluropus littoralis, Zugophyllum, album, Juncus subulatus, etc.

7. R.D. Asana (India). The physiological problems relating to crop productivity under soil salinization conditions in India.

8. A.K. Khudairi (Iraq). The toxicity of boron and the crop growth.

From American determinations the irrigation water containing 0.67 ppm B is considered toxic for sensitive crops, while for the more tolerant crops (cotton), the toxic threshold is determined to be 2-3 ppm in a liter of water. A 0.7-1.55 ppm content of boron in soil makes the soil toxic for many crops. We know, furthermore, that the addition of lime into the soil lowers the availability of soil boron for crops. The author decided to check the toxic threshold of boron while irrigating the calcareous soils of Iraq (content of $CaCO_3$ = 30%). At the same time greenhouse experiments were conducted on sand and water cultures. The toxic threshold was found when using a content of 0.8 ppm of boron in irrigation water. The toxic threshold of boron was not achieved in the calcareous soil, even when using irrigation water having a content of 40 ppm boron.

9. Kh. Golegolabe and A. Zargari (Iran). Crops in the vicinity of Masilekh and the change in their internal structure.

10. D.A. Denton, I.R. Godin, I.R. Sabine, and R.D. Wright (Australia). Adaptation of ruminant animals to a change in the salt intake.

In Australia sheep sometimes use springs as drinking water with a content up to 250-320 mm NaCl/l. The authors undertook the task of studying by physiological methods (after Pavlov-Glinskii) the salt balance of sodium and potassium as chlorides on cows, goats and sheep. The animals' adaptation to a high salt concentration of sodium was found. In experiments the variations of Na and K amounted to considerable values: Na/K ranges from 0.1-10.

The final section of our survey is devoted to 1) reports and studies which deal with saline soils and 2) the effect of salt and fresh irrigation waters on soil. Several general and stematic reports were made on this problem.

1. Ts. A. Bower (U.S.A., Salinity Labora- ry). Prognosis of the effect of irrigation ater on soils. Three problems are examined the report: 1) the effect of irrigation water the salt composition of the soil; 2) the prog- sis of the soil's effect on the qualitative and antitative composition of exchangeable ions; prognosis of the change in the boron content soil. Solution of the first problem is based the composition of the salt balance.

In anticipating the nature of the change in mposition of exchangeable cations, the author oceeds from the supposition that we should vide the root-inhabited mass or thickness in- three zones, where in the upper zone we find e exchangeable equilibrium between the soil nd the irrigation water, with the original quilibrium remaining in the lowest zone, while the middle layer an intermediate character formed. It is important in the practical nse to provide a prognosis for the first zone. he author has found Erikson's exchangeable n equilibrium equation acceptable for these rposes.

The equation for the law of mass action modi- ed by Ye. N. Gapon forms the basis of Erik- on's formula. As we shall see below, many reign authors have also referred to this equa- on as such.

The boron problem stands out quite promi- ntly in American irrigation literature, where e toxic concentration of boron in irrigation ater (0.5-1 ppm) has almost been regulated. e should say that, apparently, the "boron ar," at least as far as the calcareous soils e concerned, has been exaggerated (see the ta in the report by Khudairi).

2. In the report by I. N. Antipov-Karatayev measures to reclaim saline and bog soils nd to prevent their secondary salinization ring irrigation in Tadzhikstan, the problem as also examined regarding conditions re- ired for solonetzic soil development as a sult of irrigation by mineralized water. A -called "solonetzic" ratio of Na to Ca was termined in the irrigation water to be depend- nt upon the total salt concentration in the ater. The equation is $x = KC$, where x = the known ratio of cNa:cCa, where the exchange- le adsorption of sodium is essentially 10% of e exchange capacity; c is the total salt con- ntration in the water in g/l, K is the angular efficient equaling 0.23 (see article by I. N. ntipov-Karatayev and by G. M. Kader in Poch- vedeniye No. 2, 1959).

3. Among these systematic reports we ould also mention one by A. G. Asghar (West- n Pakistan). Use of salt water for irrigating ils, especially saline soils. The same problems are examined in this report as in Bower's report. We know that the Salinity Laboratory in the United States distinguishes the irrigation waters according to the amount of their specific electrical conductivity: a) good waters with amounts from 250-750 microhms per cm; b) poor waters which are not used for water irrigation when amounts of electrical conductivity are more than 2,250 microhms per cm; c) average amounts of electrical conductivity when we must turn our attention to the ratio of Na to the sum of Na + Mg in water. We propose forming five classes of water according to amounts of specific electrical conductivity: 0-750; 750-1,500; 1,500-2,250; 2,250-5,000 and more than 5,000 microhms per cm. The solonetzic ratio (SAR-Sodium Absorption Ratio) is calculated by using the equation for the law of mass action (as modified by Gapon). The toxic concentration of boron = 1 ppm.

4. The report by A. R. Kamalidin, Sharif Buthenia and A. Hardon (Iraq) has a doubly methodical character. The ratio of the amounts of electrical conductivity of soil paste to the amount of electrical conductivity of soil suspension is 1:1.

The system used by the Salinity Laboratory for evaluating soils by the degree of their salinization (which is widespread in many countries) consists, as we know, of determining the electrical conductivity of soil paste and the chemical analysis of an extract of soil, when the ratio of soil to water is 1:1. Considering that this system is cumbersome and requires a great amount of time, the authors decided to substitute the analyses by establishing the electrical conductivity of the suspensions 1:1, and the extract derived by this ratio. As would be expected, the ratios of the amounts of electrical conductivity are described by a complex equation with variable "constants."

Among the reports covering the general questions of soil salinization and improvement, we should mention the following:

5. V. A. Kovda. The principles in the theory ory and practice of improving and utilizing saline soils in the arid zone.

6. A. N. Rozanov. A system of scientific studies for planning irrigation and improving saline soils.

These reports will be published in Russian in a special collection of selected reports made at the Teheran Symposium, and will not be examined here.

7. D. G. Kulkarni (India). The use of salt water for irrigation and its effect on soils and crops. In the report are examined the nature and degree of the mineralization of irrigation waters of various origin in India (the lacustrine,

river, well, drainage waters). The following table gives the toxicity of these waters for agricultural crops.

1) When mineralization is up to 0.4 g/l the waters are suitable for irrigation; 2) when mineralization is from 0.41 to 0.60 g/l, if the pH value is up to 9.0 the waters are suitable; when pH is more than 9.0 the waters are unsuitable for irrigation; 3) when mineralization is from 0.61 to 0.80 g/l the waters can be used for irrigation, if the pH value is less than 8.5, but these waters are unsuitable if the pH value is more than 8.5; 4) when the mineralization is from 0.80-1.0 g/l the waters are usable if the pH value is less than 8.0, but these waters cannot be used when the pH value is more than 8.0; 5) when salinization is 1.01 to 1.20 g/l it is questionable as to whether these waters can be used at all for irrigation; 6) when mineralization is more than 1.21 g/l these waters are, generally speaking, unsatisfactory for irrigation. When irrigating with water containing 1.26 g/l of salt and a pH value of 8.78, the alfalfa yield drops. The sugar-beet yield drops when irrigated by water having 1.08 g/l of salt and a pH value 8.52; we note a repressed growth of alfalfa and sugar-beet when they are irrigated by water having a mineral content of 1.19 g/l and a pH value of 8.0. Even when irrigated by water having a mineral content of 0.51 g/l, but a pH value of 9.5, the crops are lost entirely. Thus, there has been established a limit whereby salt water can be used when mineral content is equal to 1 g/l.

In field experiments it was determined that with a salt content in the upper layer of the soil of 1.5% and more, it was very difficult for sugar-beet seeds to germinate. Similar experiments with *Susbania-aculeata* (green manure) and *Indigo-Xera trifoliata* showed the limits of soil salinization, where it would still be possible to obtain harvests, to be about 1.25%-1.5%.

The following reports are of a local character.

8. T.N. Jewitt (Great Britain). Comparison of the state of ground waters and the soil salinization in Sudan and Iraq.

9. M. Ahmad Nazir. Soil salinization of Western Pakistan.

10. Bottini Ottaviano (Italy). Customs and experimental work in Italy on the problem of using saline waters for irrigation. In the report data is presented on the chemical analyses of ground waters in Southern Italy (Bari, Taranto, etc.), which were analyzed for irrigation purposes. The dry residue ranges from 1.8-8.04-10.09 g/l. The qualitative composition of the salt is mostly sodium chloride. The sulphates are second. The waters having a salt concentration from 8-10 g/l were used for irrigating tomatoes. As a result of irrigating with these waters 10 different soils containing up to 0.1%-0.24% salt were salinized.

11. P. Simonneau (Algeria). The phenomena of changeable soil salinization. Here are described the first stages of soil salinization during irrigation in Algeria shown in the form of spotted salt formations along main canals under slightly permeable soil. Packing walls of the canals, lining them with cement and a local hard clay lowers the water filtration from the canals and at the same time lowers the phenomenon of seasonal salinization. Drainage prevents the soils from secondary salinization.

12. G. Bryssine (Morocco). Experiments in salt water irrigation in Morocco. It has been shown in greenhouse experiments that the salt concentration in irrigation water up to 1.5 g/l is not harmful to cotton plants and corn.

13. G. Druhin (Algeria). Experiments in Algeria on the use of salt waters for irrigation, especially of saline soils.

14. I.K. Jain (India). The hydrological aspect of the salinization problem and the agronomic measures required in cultivating lands, and the rational use of water in arid and semiarid zones.

15. R.G. Downes (Australia). The salinization of soils of non-irrigated regions and pasture lands, as a result of an unbalanced hydrological cycle.

16. M.A. Loenberg (Mexico). Decrease of salinization as a result of a change in the hydrological cycle.

A group of reports was devoted to measures for improving desalinization of soils. Here we shall mention the following:

17. G. Repp (Australia). Note on desalinizing soils with the aid of growing rice. Exampl of desalinizing the solonetzes in Hungary by rice are given in the report. The change in the salt content in the course of 1, 2, and 3 years under this culture has been traced.

18. A.A. Kizilova. The movement of soluble salts in the Solonchakic soils during leaching. In the report data are presented on the leaching of Solonchaks in Central Asia on small plots.

19. D. Ostan B-Dincer (Turkey). Rice culture for improving saline soils on the Chukurov Plain.

The saline soils are being developed in Southern Turkey in the semi-arid districts (with 534 mm precipitation). The following salts are predominant: NaCl, Na_2SO_4; the psiferous soils in a layer 36-110 cm have a gh percentage of exchangeable sodium (up to)% capacity). Nevertheless, the solonetzic ement is not developed during rice culture ecause of a large amount of $CaCO_3$ which is ssolved in the presence of CO_2 and displaces e exchangeable sodium.

20. M. L. Dewan and M. Bordbar (Iran). A eport on the experiments on improving saline oils by leaching in Karkkhakh, Khuzistan, Iran.

As far as improvements in Iran are conerned, there has recently been organized in eheran the Central Soil Laboratory located the suburb of Amirabad where young Persian oil scientists along with FAO[7] experts are orking. (The methods adopted in the Laboraory will be discussed below). At the Symposin three reports were presented by the Irrigaon Body of Iran. In the report by Dewan and ordbar the results of leaching saline soils by fferent amounts of water are discussed: a) ur times with 125 mm-500 mm; b) four mes, a total of 1,000 mm; c) four times, a tal of 1,500 mm and d) four times, a total 2,000 mm. The plot size is 150 square eters. The experiments were accompanied analyses of the original soils and of the oils after leaching as well as of the ground aters before and after the experiment. Bary was planted on the leached plots. Its harest increased regularly as the amounts of aching increased.

The last two reports discussed the project ata on experimental reclamation: 1) of the armzar in the Dasht-i-Kevir Desert; 2) of e drainage strip Gezel'khezar 60 kilometers est of Teheran.

21. M. L. Dewan, I. Famoori and E. Sharifi ran). A reconnaissance survey report of the nd and water resources of Garmzar Plain, stan 2, Iran. The area under study is 54,000 ectares of which 1,000 hectares has been set side for direct experiments in the Dasht-i-evir Desert. We familiarized ourselves ith several soil profiles as well as with the egetation of the area. The soils are being eveloped here on high ground waters of a loride-sulphate salinity. The authors have istinguished seven soil associations not by enetic principles, but mainly by lithological roperties and texture, and also by the degree salinization (the solonchaks). We can carcely justify separating the solonchaks-olonetzes. The surface waters of the Khableud River are characterized by a mineral ontent ranging from 0.25-1.0 g/l. The source the water salinity is the oligomiocene and iopliocene rocks of the lower parts of the slopes of the El'brus mountain ridge, among which there is a considerable amount of sulphates (gypsum).

The underground conduit waters which appear at the northern part of the desert contain up to 2.1-2.6 g/l of salt. The mineral content of the deep ground waters is 11.3 g/l; the salinity has a chloride-sulphate character and the specific sodium share amounts to 50%-72% of the total cations. The maximum salinity of the upper horizon of the soils totals as much as 3% and has a sulphate-chloride character. The analytical data available in the report turned out unfortunately to be incomplete. While becoming familiar with the soil profiles we saw a schistose (bedded) formation of gypsum layers of considerable thickness (up to 3-5 cm) along the lines where the alluvial deposits shift. These observations were not mentioned in the report. We collected soil material which will be subjected to special analyses.

Within the Garmzar area we were able to examine working examples of reclaiming salinized areas by 5-6 year leachings on a drainage area (2.5 m in depth, with the drains about 200 m apart). A part of the farmer's leached area began to give satisfactory yields of alfalfa. Wide cultivation of the Dasht-i-Kevir Desert will be limited by an insufficient amount of irrigation water. The repeated use of return water by constructing underground water conduits with wells (cables) is deserving of attention.

22. M. Avasi. Drainage and improvement of Gezel'khezar.

This experimental area for melioration is situated 60 kilometers west of Teheran on the Teheran-Kazvin highway in the Keridzh district. We were twice able to visit this area of 750 hectares which is located in a declining zone (dying out) of relatively fresh ground waters which are nourished by the waters of the southern slopes of the El'brus mountain ridge. Under the influence of ground waters close to the surface, meadow soils are being developed which in places become meadow solonetz-like and solonetzes as well as solonchak-solonetzes with a typical soil profile. The drainage project studies were begun here in 1955. Based on the analytical data presented in the report, the water of the conduit system has a mineral content of 0.570-0.860 g/l, but from a deep well (33 m in depth) the mineral content is 1.3 g/l. In this last instance there was up to 14.5 meq/l of sodium carbonate. The saline soils contain calcium carbonate beginning from the very surface. Gypsum in very small amounts is found almost in all the horizons of these soils. The percentage of water soluble salts is quite high with an obvious presence of sodium carbonate up to

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[7] Such specialists of non-arid profile are all alike.

1-1.2 meq. Sodium — up to 15-25 meq/100 g of soil occupies an important place among the exchangeable cations.

It has been shown that in the project only the drainage and leaching aspects have been envisaged. We had to point to the need of including into the project the chemical melioration measures for improving the solonetzes. We shall be able to speak of the determinations of gypsum or of other calcium salts only after samples of several profiles which we had delivered to our laboratory have been analyzed.

Considering the foregoing investigations, it would be appropriate to dwell briefly on a system of methods for studying soils under laboratory conditions, a system adopted in the very recently organized Teheran Central Soil Laboratory. This system of analyses followed to a great extent standard procedures which are being used in the Salinity Laboratory of the United States at Riverside, California.

Particle-size analysis. A weighed portion of 50 g of soil is mixed in a solution of sodium hexametaphosphate; the suspension is stirred for 15 minutes in the Bouyoucos dispersing machine and then placed in a liter cylinder to a certain mark. The analysis is measured with a hydrometer for fractions 2-0.2 mm (sand); 0.2-0.002 (silt) and <0.002 mm (clay). The hydrometer readings are taken at specified time intervals (see Raymond F. Dawson, Laboratory Manual in Mechanics, Pitman Publishing Corporation, New York and London).

Chemical soil analysis. The total salt content is expressed first by the amount of electrical conductivity in the reciprocal ohms per cm of soil paste;[8] second, the total salt content is determined by analyzing the water extract when the ratio of soil to water is 1:1. Filtration is accomplished by a dense filter used during suctioning. The dry residue is determined in the filtrate: $Ca^{++} + Mg^{++}$ is determined by using versenate; Na^+ and K^+ are determined by the flame photometric method, $SO_4^=$ by the gravimetric method, and $CO_3^=$ and HCO_3^-, Cl^- by titrimetric methods. The analytical data is expressed in meq/l of extract.

Gypsum percentage is determined in the water extract when the ratio of soil to water is 1:50. Gypsum is precipitated from the water by applying acetone in equal extract to the contents; Ca and Mg are determined in the extract.

Humus percentage is determined by volumetric method.

Alkali-earth carbonates are determined by the neutralization method by processing 1n HCl.

Determination of the pH value in the soil paste and suspension is 1:1 and 1:5.

Composition of exchangeable cations. The adsorption capacity is determined by the satur
tion with ammonium acetate. The exchangeab
sodium is determined in the same extract. Th
correction for water soluble sodium is include

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[8] The amount of water required to bring the soil to a paste state is extracted as the indicator of the saturation percentage.

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DISCUSSION

THE PROBLEM OF CLASSIFYING BOTTOMLAND SOILS OF THE FOREST ZONE[1]

V. I. SHRAG

Pochvovedeniye has published an article by G. V. Dobrovol'skiy devoted to classifying bottomland soils of the forest zone.

In the introduction to his article Dobrovol'skiy correctly notes that: "the classification problems are among the most complex in soil science" and "that the classification of bottomland soils is the most undeveloped area in soil classification."

At the same time as individual soil scientists were paying attention to bottomlands, soil science literature was being enriched with interesting data describing the original and peculiar character of the flood-plain landscape and of the soils as its component (L. I. Prasolov, B. B. Polynov, V. A. Kovda, I. I. Pliusnin, etc.). In about the last 10 years, when the Party and the Government were turning their attention to the need of intensively cultivating flood-plains, and many kolkhozes and sovkhozes were beginning to get unusually high yields on these lands, mostly vegetables and hay, our soil scientists began to exert considerably great efforts in studying bottomland soils.

Dobrovol'skiy, by right, should be considered as one of these soil scientists. He has published a series of interesting articles in various journals (Pochvovedeniye, Herald of the Moscow University, Hydrotechnics and Improvement); he has gathered data for these articles on the whole, from personally conducted investigations of the forest zone flood-plains.

As a soil scientist concerned with the problems of studying bottomland soil formation and highly valuing Dobrovol'skiy's contribution to the study of bottomland soils, I should like to make several critical observations.

The separation of bottomland soil formation into three groups or processes, namely, sod, meadow, and bog, is the fundamental principle of Dobrovol'skiy's proposed classification. By the sod process he means "that process of soil formation which occurs under the influence of grass under soil moisture conditions taking place only by surface waters whereas the meadow process is being developed under the conditions of an atmospheric-ground moisture and, consequently, is accompanied by an accumulation of not only humus and biogenic accumulative elements, but in contrast to the sod process, is also accompanied by a hydrogenic accumulation of elements from the ground waters. The bog process under fluvial flood-plain conditions occurs during excessive ground moisture, inadequate aeration, periodic flooding...".

This principle of dividing the flood-plain soils depending upon the character of the soils' water supply was met with earlier in D. G. Vilenskiy's work but with a somewhat different interpretation: the sod and meadow soils were viewed by Vilenskiy as subgroups of one sod-meadow group of soils. Dobrovol'skiy proposes associating these subgroups with different soil formation groups, apparently assuming that by doing this he will eliminate the "particularly great lack of coordination which exists in determining meadow and sod soils" (Dobrovol'skiy, "Problems on the theory of soil formation on river bottomlands in the forest zone." Herald of the Moscow State University, 1957, No. 1). As we know, V. R. Vil'yams devoted much of his creative efforts to developing theoretically the essence of the sod process. Dobrovol'skiy mentions this by saying "the greatest triumphs in the study of bottomland soils belong to Vil'yams ... Especially of great significance in this regard was the sod process theory developed by Vil'yams, based on dividing bottomlands into genetic regions." We recall that the sod period (process), after Vil'yams, includes the successive stages: ... meadow, bog, and chernozem, which he associated with a definite evolution of the biological factors and, first, with a change in plant formations. At the same time he considered that "the development of the rhizome phase in the sod period of the soil-forming process is replaced by the loose shrub phase of the meadow stage," (Selected works, Volume 1, page 26 and 56, 1949), and that "on the bottomland we find the most perfect example of natural development of the sod period of soil formation" (Selected works, Volume 1, page 117). We could cite many more of Vil'yams' views on this problem. However, not in one single instance did Vil'yams make dependent the development of the sod and meadow processes upon the presence of a "surface" or "atmospheric-ground" water supply, as Vilenskiy and (especially) Dobrovol'skiy did, disclaiming freely or otherwise Vil'yams' theory of the single soil forming process.

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[1] In the article by G.V. Dobrovol'skiy "Classifying Soils of the Forest Zone" Pochvovedeniye, No. 8, 1958.

Of course, we cannot agree with Vil'yams and we must amend his views somewhat, but these corrections should be fairly substantiated.

Dobrovol'skiy's basic mistake is the contrast on the flood-plain of the atmospheric-ground and surface supply of water. The author underestimates the fact that a peculiar hydrogeological cycle associated with the so-called alluvial water supply is characteristic of the flood-plains. This fact is responsible for the extreme instability of the water table which is being periodically undernourished and often even fed entirely by flood-waters.

During spring, high water and (especially, at the lower courses of the rivers, when flood waters on the bottomlands stay for several weeks, and even months) the ground and surface waters in the whole area flooded by spring high water are completely united. As the water levels during flash floods recede, the draining significance of the river begins to become important, as a result of which the ground water levels are slowly lowered. It is quite natural that, as the years go by, the dynamics of this process for the different rivers and various sections of bottomland are far from being alike. For certain bottomlands, which are not being periodically flooded by spring high waters, the ground waters in "dry" years sink to great depths (for example, on the bottomlands of the Ural, Dnestr, and Belaya Rivers). Only in terraced regions are ground-water levels for part of the bottomlands more stable. Thus, the effect of ground waters on the soil forming processes on bottomlands is a very complex factor and is almost always dependent upon the nature of spring high waters. At the same time on the bottomland, as long as it remains within flooding stage, there are no soils which do not experience in some degree the ground-water effects. We can distinguish only the degree of this effect, which in very small measure may act as a criterion for separating the two groups of bottomland soil formation proposed by Dobrovol'skiy.

We shall illustrate this by a few examples. For the most extensive Obskaya bottomland located below the mouth of the Irtysh River, and characterized by an extremely lengthy flooded state, the ground waters on the whole bottomland over an entire vegetation period (perhaps, with a rare exception) rest at levels which caus their capillary rise to the root-inhabited soil layer. Here the mesophytes and hydrophytes predominate in the vegetation aspects. Thus, according to Dobrovol'skiy, only meadow and bog soils should be developed here and, at the same time, in this predominantly insular botto land we constantly find vast soil areas which, according to Dobrovol'skiy, fall into the "weakly developed sod and sod soils." Another example is the Belaya River bottomland. Here, as far as the progressive lowering of the erosion base is concerned, high spring waters are at present flooding for a very short period of time large areas of the high bottomland; some years these spring high waters do not ove flow at all. In the post-spring flood condition the ground-water levels in the central bottomland area covered by thick "meadow" soils (after Dobrovol'skiy) are situated at depths which totally exclude the undernourishment of the root-inhabited layer by these waters. In the vegetation classifications the thin and dense clumps of grasses (*Festuca sulcata*, *Stipa*, *Koeleria cristata*, *etc.*) are predominant. The same soil hydrological conditions are seen also on the Dnestr and Oka River bottomland (where, incidentally, Dobrovol'skiy worked) along the broad ridges of the high flood-plain.

Why do these soils which, in connection with a lowering of erosion base and a diminution of the flooded state that is responsible for lowering the ground water level, move from the "meadow soil" group into the "sod soil" group? This evolution seems to us paradoxical.

We should dwell yet on one case of the peculiar hydrogeological cycle in the bottomlands, which is quite often encountered. On the rivers of the Far East, the Kalingradskaya Oblast', the Dnestr marshlands, the Dema River bottomlands (Bashkir ASSR), etc., we find among the alluvial deposits dense, silty clay occurring at a small depth from the surface (30-80 cm). The flood and rain waters, percolating without difficulty through the upper, usually well aggregated soil horizons and falling onto an impervious bed, forming a perched water table which remains here at various times. Whenever the water stands for a long time, water-logged and bog soils are formed, although the ground waters do not strictly participate in soil formation. In a large number o cases the different "meadow" soils are developed under seasonal water conditions — a type of wet meadow soils. In "dry" years perched water may be entirely lacking or of very short duration. This type of water supply in the bottomland soils has not been noted by the author of the classification.

From what has been said, we should conclude at Dobrovol'skiy incorrectly interprets the alue of the quite complex hydrogeological enomena in bottomlands during their soil rmation.

In the bottomland "meadow" soil group Dob- ovol'skiy separates the acid and neutral soil roups, i. e. he includes in the classification dex the expression of an acid radical. We ust doubt the expediency of such a method ecause, by taking such a position, it would e consistent to distinguish in the bottomland oils of one or another content of potassium, osphorus, etc., which is no less important an the soil reaction.

In his article the author does not come for- ard with a definition of what he considers the riterion for relating bottomland soils to acid r neutral soils. We shall dwell on this, be- ause in his article published in the Herald of e Moscow State University, 1957, No. 3, Several peculiarities of the geography and ycle of bottomland soils," the author associ- tes with soils having a neutral reaction those oils wherein the salt pH value is 4.9-5.8 (?) ages 130-131). At the same time we also nd on the bottomland soils with an alkaline eaction, as for example on the bottomlands of e upper courses of the Moscow and Belaya ivers, etc.

In this case it seems to us more expedient ot to separate soils on the bottomlands which re characterized by a different reaction of e solution, but to describe the alluvial de- osits of one or another fluvial bottomland or o describe sections of the bottomland with espect to their chemical composition, which s most intimately associated with the geologi- al structure of the river basin, and also with egard to texture with which, incidentally, the uthor does not concern himself. In conclu- ion, I should like to dwell on a few remarks ade by Dobrovol'skiy in this article, in con- ection with my article "Experiment in Classi- ying Bottomland Soils" published in Pochvove- eniye No. 11, 1953.

He considers "bulkiness" as one of the short- omings of this classification. In our "Experi- ent in Classifying Bottomland Soils," which s related to bottomland soils of all natural ones in the Soviet Union, 26 basic groups nd subgroups have been distinguished; in the lassification scheme proposed by Dobrovol'- kiy for the bottomland soils of only the forest one, 24 basic groups and subgroups are men- oned. It appears that the "classification ex- eriment" deserves reproach of an opposite rder — namely, that Dobrovol'skiy did not ufficiently or adequately include the entire reat variety of soils found on the bottomlands the rivers of the USSR. Thus, for example, this "experiment" the group of saline water meadow soils, etc., have only been slightly dealt with. Further, the author writes, "Shrag considers correct the preservation of the names for stratified, granular-stratified and granular soils as genetic terms. It seems to us to be more correct to use the terms stratified or granular only for the morphology of soils or for bottomland alluvium (? — V. SH)"

Actually, we strove as much as possible to preserve the soil terminology already in use and customary for many soil scientists, agronomists and other agricultural specialists. We should scarcely consider it an achievement to suggest a new soil nomenclature when there is no particular need for it.

This concerns not only the stratified and granular soils of Vil'yams whose contribution to the science of bottomland soils we value, but also those soils such as "wet-meadow," "meadow bog," "sod," and others of which soil scientists have clear genetic and morphological views. Dobrovol'skiy is absolutely wrong when he denies the expediency of using morphology for developing soil terminology. From his point of view, we should reject such terms as chernozems, krasnozems, podzols and many others.

Justifiable is the remark by the author that in our published "Experiment" there remain vague genetic relationships among the varieties of bottomland soils within stages ... although, we have tried to realize this in the text. Being restricted in the amount of space alloted to a magazine article, we were unable to clarify to any suitable extent the existing genetic relationship among the different groups of bottomland soils within each stage. Incidentally, in Dobrovol'skiy's proposed classification scheme this relationship among the separate genetic groups also is far from being clear.

Let us be somewhat more precise: we never did consider that the bottomland soils in the second stage of development "do not possess features of the zonal soils." It was mentioned in our article that "the second stage includes those soils ... which do not as yet have clearly-expressed zonal features peculiar to watershed soils." The difference between our conception and the exposition of it by Dobrovol'skiy, obviously, does not require explanation.

From all that has been said, it seems we may conclude by saying that we must continually turn to the problems of classifying bottomland soils by delving deeper into those natural phenomena which are being developed under the unique and peculiar conditions of river life and of its bottomlands, and by taking into careful consideration what has been done earlier in the study of bottomlands, beginning with the teaching of Vil'yams.

CLASSIFYING SOILS OF THE ROSTOVSKAYA OBLAST'

M. M. SUGROBOV

F. Ya. Gavrilyuk's (1) article "Classifying Soils of the Rostovskaya Oblast'" published in Pochvovedeniye was based on a strictly genetic principle and practically covers all varieties of soils in the Oblast'. This article further clarifies and improves upon the first classification of soils in the Rostovskaya Oblast' prepared by S. A. Zakharov (2) and is of great interest for the study of soils not only in the Rostovskaya Oblast' but also in adjacent regions.

The Rostovskaya Oblast' is unusual in the soil-geographic sense. It comes in contact with the south Russian steppes and the Predkavkazskye steppes and the Prikaspiiskaya semidesert. A regular shift of horizontal soil zones in a latitudinal direction is disturbed by the proximity of the Black and Azov Seas, which moderate the continental nature of the climate in the west. Consequently, the soil zones and subzones extend in a meridional direction from west to east. As a result we find most soil groups and subgroups in the Oblast' to be typical of the southeast part of European USSR. Since we attach considerable importance to Gavrilyuk's soil classification, we consider it necessary to discuss several of his ideas.

1. The basic groups of soils of the steppe were subdivided into subgroups according to basic morphologic-genetic features (by percentage of organic matter and character of the profile structure and salt regime). The chernozems are divided into ordinary, southern, etc.; the chestnut soils are divided into dark-chestnut, chestnut, and light-chestnut. Subgroups were further subdivided into soil species according to "secondary" features of calcareous, solonetzization and leaching.

However, this rigid principle somehow is violated in the classification of soils of the meadow-steppe and meadow subgroup. Here subgroups are divided not by basic morphologic-genetic features (humus, substance, rate of the meadow process development) but by "secondary" features: carbonation, solonetzization, and solodization; a further subdivision into species was made according to the development rate of these features. We would like to do away with this contradiction, so as to impar a more orderly scheme to the classification.

2. In classifying, chernozems were subdivided by the thickness of humus horizons, according to a classification scale adopted at the All-Union Conference of 1950, where chernozems having an A + B horizon thickness less than 40 cm were placed into the shallow chernozem category, while the thickness of the moderately thick chernozems and the excessively thick (deep) chernozems were 40-80, 80-120, and over 120 cm, respectively. The convenience of this scale can be seen from the fact that it permits us to unite under one system all known subgroups of chernozems. However, there is a negative side to this scale, because by such a division one of the important regional features of the Predkavkazskiye chernozems is obscured — their thickness which served as one of the basic reasons for dividing these soils into an independent soil subgroup. Thus, based on the vast amount of data available on the morphology of chernozems, soil scientists of the Administration For Land Development stuck to the following thickness intervals for the A + B horizons: a) for the Predkavkazskiye and Priazovskiye chernozems, 65-75 cm for shallow chernozems, 75-100 cm for moderately thick chernozems and over 100 cm for thick chernozems; b) for typical (moderately thick) southern chernozems A + B ranging from 45-75 and for shallow chernozems A + B ranging from 35-40 cm.

3. Studies of recent years have shown that misunderstanding has come about only from using the term "leaching" applied to Predkavkazskiye and Priazovskiye chernozems in the Rostovskaya Oblast'. We understand that by leaching is meant not only a reduced effervescence of HCl, but also a migration of the sesquioxide colloids. We observe in the chernozems of the Oblast' a reduced effervescence

m 10% HCl, for these chernozems as a rule
found in the lowered elements of the relief
are distinguished by a water regime which
embles soils of the meadow-steppe subgroup
ditional moisture). There are instances of
wered effervescence also under flat water-
d area conditions (zonal conditions) of oc-
rence in the transition variants of the Pria-
skiye chernozems to ordinary chernozems
of the Predkavkazskiye chernozems to south-
chernozems, for which an effervescence
m 10% HCl at a certain depth (35-50 cm) is
enerally typical zonalgenetic feature. Analyt-
data bears out a similar percentage of car-
ates in the southern chernozems and in the
called "slightly leached" Predkavkazskye
rnozems (ranging from 0.05%-0.15% CO_2).
vever, the southern chernozems do not fall
the leached category. It is considered
re accurate to stay clear of the term "leached"
pplied to Priazovskiye and Predkavkazskiye
rnozems, which have a reduced effervescence
m 10% HCl, and to substitute slightly leached
the "low carbonate" and moderately leached
the leached chernozems. We only find the
cal leached Predkavkazskiye chernozems in
ropol' and Kuban.

l. Of particular note is the fact that Gavril-
divided soils according to the degree of
netzization by using N. A. Kachinskiy's
ssification and not the scale of N. I. Antipov-
atayev. This switch is not accidental. The
rmous amount of analytical data on the com-
ition of exchangeable cations gathered in the
ast' shows that Kachinskiy's scale answers
re the need of soil scientists and manufac-
ers than Antipov-Karatayev's scale. Our
lies have uncovered the reasons for this.
as been shown that in the solonetzic soils of
Rostovskaya Oblast', which have a compara-
ly small percentage of exchangeable sodium,
re exists a considerable amount of adsorbed
gnesium which intensifies the solonetzization
in soil. It has been proven that there is direct dependence between the degree of solonetzization and the ratio of adsorbed Ca to Mg. When the degree of solonetzization increases, the ratio of Ca to Mg steadily increases. The following gradations have been derived: a ratio of Ca:Mg more than 4.5 for the nonsolonetzic soils; from 4.5-3.5 for slightly solonetzic soils; from 3.5-2.5 for moderately solonetzic soils, from 2.5-1.5 for severely solonetzic soils, and less than 1.5 for typical solonetzes. Presently these gradations are used as "secondary indicators of solonetzization" during large-scale soil surveys conducted by the Administration for Land Development.

5. Gavrilyuk's soil classification scheme unfortunately does not include chernozems and chestnut soils of sandy areas in the Oblast'; their genetic and agricultural-productive importance have not as yet been determined. The eroded soils are also missing in his classification. Therefore, we must supplement his soil classification with classes for sandy and eroded soils.

In summary, Gavrilyuk's soil classification scheme is valuable and timely. Using it as their basis, Rostov soil scientists are presently working out a site index for soils of the Oblast'.

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A STUDY OF SOIL EROSION BY AERIAL PHOTOGRAPHS

N. N. SEMENOVA

Today, aerial photographs are used much more extensively for soil maps. The use of aerial photographs significantly accelerates the compilation of both conventional and special soil maps, especially those intended for definite purposes such as maps designed for the prevention of soil erosion.

The effectiveness of aerial surveys for soil erosion studies is indicated in the works of Soviet scientists (8 and others), whose observations are confirmed by foreign scientists (11, 12).

In 1957, an expedition of the Laboratory of Air Survey Methods, Academy of Sciences, USSR surveyed the dynamics of recent processes on the coast of the Tsimlyansk water reservoir. In addition to other problems, the expedition studied erosion processes by using aerial surveys. This problem acquired specific importance for the reservoir not only due to the need for protecting coastal farm lands from erosion, but also to prevent the reservoir and its inlets from snow drift, silting, and the formation of sand bars and banks formed by the mass of soil particles eroded from the slopes.

A study of erosion and of the extent and properties of eroded soils was conducted primarily on the territory of two key areas — Khoroshevsk (on the western coast of the reservoir) and Primorsk (on the eastern coast). Since soil erosion was found to be closely related to the geographic conditions of the locality — relief, climate, soil-forming parent material, vegetation, etc., we investigated the erosion and degradation procesinto of the entire coastal area and the adjacent slopes of the watershed. The problem comprised the establishment of a relationship between the various factors effecting the process of soil erosion, and between the degree and rate of erosion; we were also attempting to establish indicators to decipher the eroded soils on the aerial photographs.

The following topographic maps, photodiagrams, and aerial photographs of various sc and years of survey were used during the st

1. 1:25,000-scale aerial photographs, pa chromatic film, August-September, 1948.

2. 1:10,000-scale aerial photographs, pa chromatic film, June, 1955.

3. 1:10,000-scale aerial photographs, pa chromatic film, May-June, 1957.

4. 1:5,000-scale aerial photographs, pan chromatic film,

5. 1:10,000-scale color aerial photograp July, 1957.

The indicated studies were conducted ela ately along contours superimposed over all characteristic elements of the topography. Contour lines were marked on the topograph map as well as on photodiagrams on which i was possible to distinguish a series of regio varying in the intensity of erosion, type of erosion, etc. by the difference in photograp outline.

The complex contour lines had a geodetic base and were plotted on 1:10,000-scale pho diagrams.

Each contour line on the photograph whic differed from others in its graphic image wa characterized from the viewpoint of soil, ge botanical, and other elements.

This was done to establish indicators for the diciphering of soil differences and to sep arate them by degree of erosion.

The greatest number of soil profiles and holes was obtained from the most dissected points in areas which corresponded to the more variegated parts of the photograph.

The factual data about the nature of soil differences and their images on aerial photo s were later applied to the entire territory. we were able to compile soil maps which guished soils by their erosion categories.

f Characterization of Natural Conditions of Investigated Regions

e investigated regions were located within nits of an arid steppe zone characterized ontinental climate with a hot dry summer cold winter with little snow.

e meteorological conditions of the dis- small amount of winter precipitation and inter temperatures, heavy summer pre- tion, etc.) contribute to the strong de- nent of erosion processes.

e investigated regions differ rather strong- m one another with respect to the nature ir topography. Khoroshevsk area is lo- on the high western coast of the reser- nd is dissected by a dense network of s and ravines. The region's highest reach 130 m and more. The steepness slopes varies from 0.5 to 10-15° within gions limits.

e recent scarps and ravines, together with of old erosion, are widespread in the Soil erosion processes are highly de- ed.

imorsk area is located on the low eastern of the reservoir with absolute altitudes 80 m. A large portion of this area is lo- within the limits of the high flat terraces Don River valley which are characterized insignificant dissection of ravines. As a he steepness of the slopes does not ex- 1.5-2°; the processes of sheet erosion are ronounced.

e soil-forming parent materials in both are primarily loess-like clay loams; e and average in texture; calcareous, s, and poorly resistant to erosion. The of loess-like clay loams reaches a maxi- on the water divide, while on the slopes dually decreases, reaching a minimum on epper slopes where there are outcrops of g hill clays or Pontic limestone.

e rolling hill clays and their eluvium and ium comprise the soil-forming parent ma- on the steep slope of the watershed (Khor- sk portion) and on the eroded terrace orsk portion). This parent material is cterized by a significant calcareous content, orosity, slow water permeability and a usceptibility to freezing.

e distribution of Pontic limestones is r limited. They are adapted to the steeper n of slopes within the limits of Khoroshevsk area.

The vegetation of investigated regions is characterized by considerable sparseness. The projecting cover of the more widespread wormwood-grass (Festuca sulcata) and grass-wormwood groups does not extend over 60%-70%; it is often equal to 30%-40% (in pastures). This vegetation does not form a continuous sod cover and, therefore, does not prevent soil erosion. Generally a large portion of the territory has no natural vegetation as a result of its plowing for many years.

The soils of the investigated regions are chiefly southern chernozems changing to dark chestnut soils (Khoroshevsk area) and to dark chestnut soils (Primorsk area), both types developed on loess-like clay loams. No significant difference in the morphology of the profiles or in the chemistry of these soils is observed.

The more developed soils prevail on the flat watersheds developed on deep loess-like clay loams. If we disregard deflation which occurs in plowed areas, these soils under zonal conditions are not susceptible to the effect of erosion.

The following constitutes a morphological description of southern chernozems which change to dark chestnut soils: The depth of A horizon is 30-35 cm and that of B horizon nearly 20-28 cm. A carbonate horizon, 30-40 cm thick, occurs at a depth of 65-70 cm. It is enriched by white specks. Effervescence begins at 30-40 cm, while in other instances it starts at the surface. As a result of breaking up from constant plowing the soil clods are not stable.

These low-humus soils (the humus content in upper horizons does not exceed 3.5%-4%) contain a large amount of carbonates; the adsorption capacity in upper horizons approaches 40 meq; the predominant cation in the adsorbing complex is calcium. The nature of dark chestnut soils is approximately similar.

The described fully developed and non-eroded soils were accepted as a standard in determining the degree of erosion of soils developed on loess-like parent material on slopes of varying steepness and exposure. Soils developed on watersheds were excluded. More accurately, we took the thickness of the humus horizon, which we defined as the A horizon and the transitional AB horizon, i. e. the entire horizon showing an intense dark coloring.

In classifying the soils by their degree of erosion, we followed the classification proposed by Shaposhnikov (10) for southern chernozems and dark chestnut soils. On the basis of this classification, we considered as the slightly eroded type those soils whose humus horizon was 5-8 cm thinner than in soils developed under zonal conditions (25% of the humus horizon eroded). The moderately eroded soils were 10-12 cm thinner (30%-40% removed) and the heavily eroded soils 15-18 cm thinner (50%-60% removed) than the standard.

We took into consideration the thickness of the humus horizon and also the intensity of its coloring in deciding the degree of soil erosion. This factor is very important, since the coloring of a soil's upper horizon affects the tone of its photographic image on the aerial photographs which we used to establish the degree of soil erosion.

Eroded soils differ from non-eroded soils primarily in their humus content. Even in slightly eroded soils the humus content in the upper horizon is significantly less than in non-eroded soils (2.4% as against 3.45% in southern chernozems grading to dark chestnuts). As eroded soils lose their humus, their structure deteriorates and they are still subject to a large extent to the erosive process.

The degree of erosion of a soil may be judged by its CO_2 carbonate content. Horizons with maximum carbonate accumulation in eroded soils lie close to the surface.

In slightly eroded dark chestnut soils a significant percentage of CO_2 (4.16%) is observed even at a depth of 20-40 cm, while the strongly eroded upper horizons are even more enriched in carbonates.

Loess-like clay loams are not the only soil-forming parent materials; there are others such as clays and Pontic limestones.

The Effect of Various Factors of Soil Erosion and the Interpretation of Eroded Soils in Aerial Photographs

In studying soil erosion we endeavored to show relationships between the degree of soil erosion, the forms of scouring, etc. and the factors affecting the erosive processes. On the basis of these relationships we established the appearance of various degrees of soil erosion on the aerial photographs.

Attention was paid first of all to the steepness of the slopes, the soil erosion effect which is always stressed first (4, 6, 9, and others).

Observations along sections with measurement of slope steepness at different points and with description of the soil profiles at these points permitted us to draw a conclusion about the association of variously eroded soils with particular degrees of slope steepness. In both areas slightly eroded soils are associated with 1-2° slopes; moderately eroded soils with 2-2.5° slopes; and strongly eroded soils with slopes of 3-4° or more. Departures from this rule are very often observed within the areas inve tigated. Thus, for example, strongly eroded soils are also encountered on slopes of no more than 2-2.5°. This is conditioned by a sudden change in the slope's form and the thic ness of the stratum. Such a phenomenon is o served on the crests of the slopes and on slop with a thin covering of loess-like clay loams over soft clays.

Soils of different degrees of erosion show definite character in aerial photographs.

The observations permitted us to set up a number of indicators for identifying eroded soils.

The most reliable interpretative indicator is the tone of the photograph. This is the earliest indicator for differentiating soils on aerial photographs by their degree of erosion especially in plowed areas where the surface soil horizon is depicted directly. The tone of the photographic image depends on the thickness of the humus horizon and on its humus content. When the thickness of the humus horizon is considerable, the tone of the photo graphic image is most intense-dark gray or dark and uniform. This corresponds to a non eroded or slightly eroded soil. Reduced humu thickness and the lifting of a portion of the AB horizon or even of the B horizon to the surfac during tillage lightens the surface and thus lightens the tone of the photograph.

The lightest ground on the photograph (Fig. 1) represents the soil with the shallowest humus horizon, i. e. a strongly eroded soil. The alluvial fans of gullies, associated with level areas under the crests of slopes, are al depicted by a light shade. The light shade is explained by low-humus deposits (mellow pro luvial-deluvial clay loams) approaching 0.5 m in thickness.

The greatest tone contrasts are observed in aerial photographs of recently plowed areas that have not yet dried out or in aerial photographs of areas with young growth which does not conceal the surface of the soil. Stub conceals almost completely the tone differenc in photographs.

However, even in photographs of plowed land it will be difficult, for example, to distinguish by tone mildly eroded soils, which show the same tone as non-eroded soils. In this case one is aided by a characteristic patt on the aerial photographs produced by the den network of waterways — small drainage gulli The waterways produce a very definite photographic image in the form of straight or twist ing and branching narrow dark bands, well-defined on both plowed and non-plowed areas

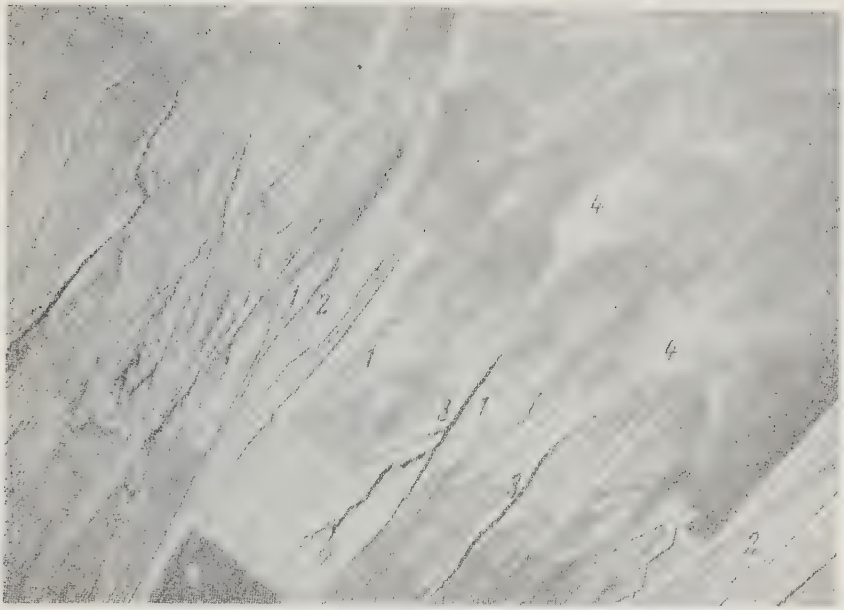

Fig. 1. - A 1:10,000-scale aerial photograph. Panchromatic film.

1 - Strongly eroded southern chernozems, grading to dark chestnut soils; 2 - erosion ravines; 3 - gullies; 4 - alluvial fans.

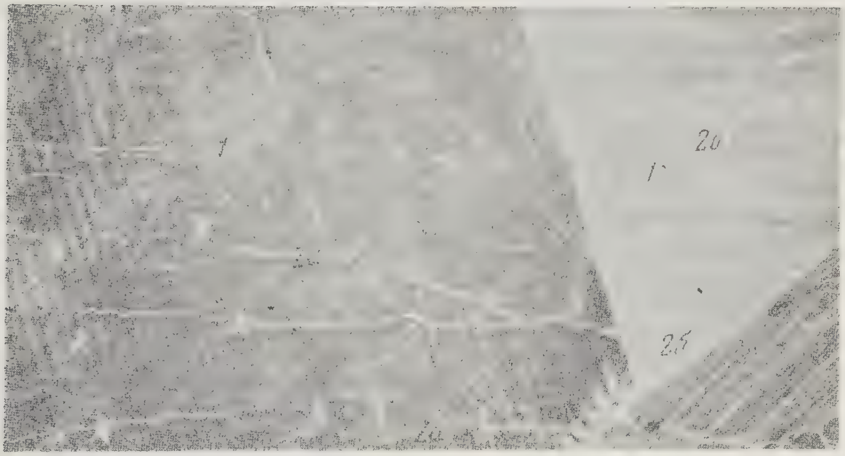

Fig. 2. - A 1:10,000-scale aerial photograph. Panchromatic film.

1 - Slightly eroded southern chernozem, grading to a dark chestnut soil; 2 - waterways with furrow erosion; a - in fallow; b - in a field with winter crops.

gs. 2 and 3). Their dark color is the result heir thick humus horizon (45-80 cm), their ndant moisture, and to the dense grass on non-plowed areas.

Waterways 30-60 (sometimes 80-100) cm p and 20-30 m wide, are associated with g, flat slopes of 2° or less and at the head basins of ravines. Slightly eroded soils are particularly associated with these topographic elements. Thus, by determining the boundaries of the pattern formed by the photographic image of the waterways, it is possible to distinguish the outlines of the slightly eroded soils.

Narrow zones of strongly eroded soils,

Fig. 3. - A 1:10,000-scale aerial photograph.

1 - slightly eroded southern chernozem, grading to dark chestnut soils; 2 - strongly eroded southern chernozem, grading to dark chestnut soils; 3 - waterways; 4 - suslik burrows.

represented on the aerial photographs by a light tone, are often encountered along deeper waterways having well-defined bluffs and prominent slopes. It is often possible to observe a stream channel along the bed of the waterway. These appear on the aerial photographs as narrow light zones and correspond to the beds of intermittent streams.

Moderately eroded soils are distinguished in aerial photographs not only by the tone of their image, but also by the appearance of the stream channels or by the shallow (not more than 30 cm deep) and narrow (5-10 m wide) waterways associated with them. These are straight and short in contrast to ones previously described. A dense grouping of such waterways forms a corrugated pattern on the photograph of a slope (Fig. 4).

The boundaries of strongly eroded soils associated with sharp crests of slopes and with the coastal terrace, are indicated by a network of short parallel erosion ravines and gullies. These are seen distinctly on aerial photographs as very dark and sometimes black bands (Fig. 1).

Thus slope steepness affects development of these or other forms of linear erosion, which stand out distinctly on aerial photographs and serve as auxiliary indicators in the identification of eroded soils.

An indicator such as the shape of an outline being interpreted is sometimes used in identifying eroded soils. This indicator is helpful chiefly in identifying strongly eroded soils, which, as a rule, are located in comparatively narrow bands along gullies, ravines, waterways and on the steeper crests of slopes; they appear as light zones of straight-line configuration.

We were unsuccessful in our attempt to determine the effect of slope length on the degree of soil erosion, since no slopes of different length were observed in the areas investigated with all other conditions equal (steepness, shape of the slopes, and thickness of the loess-like clay loams covering the slopes).

There are indications in the literature (1, 4, 8) that the degree of soil erosion increases in the lower portion or at the foot of long slopes, but this has not been verified by observation in the areas investigated. Thus, for example, on a slope more than 5 km long running from the water divide to an arm of Karaichki ravine (Khoroshevo area), erosion is quite insignificant in both the upper and lower portion. This is probably explained by the gradation of the slope (the alternation of slightly sloping and level areas) which tends to slow down the flow. This is also the result of alternated plowed and non-plowed areas.

According to many authors (7, 8), steepness and length are less important on complex (i. e. combined, for example, convex-concave) slopes than on continguous areas of slopes differing in steepness. The long slope to Karaichki ravine (Khoroshevo area) is an example of such a combined slope in the area of investigation. Short,

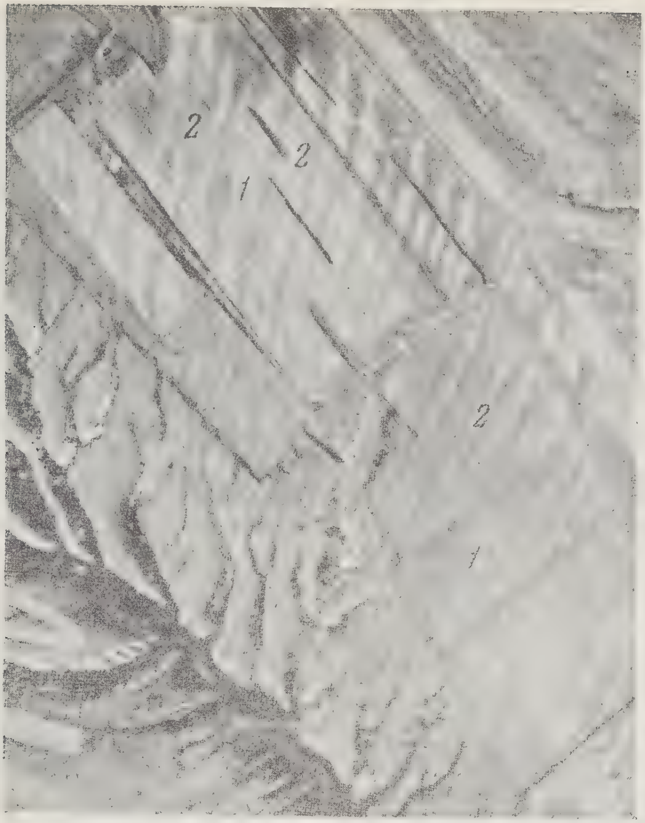

Fig. 4 - A 1:10,000-scale aerial photograph.

1 - Vineyards on moderately eroded southern chernozems grading to dark chestnut soils; 2 - shallow waterways; 3 - ravine.

teep benches on this slope meet level areas,
here material carried down from the higher
ectors accumulates.

The effect of exposure on the degree of soil
rosion appears to differ in different cases.
o significant difference in the degree of soil
rosion on long flat NE and SW slopes has been
bserved in the Khoroshevo area. Slightly
roded soils predominate on this and other
lopes and are identified on aerial photographs
y the same tone and a similar pattern. A
enser network of waterways with zones of
rongly eroded soils along the bluffs was noted
n aerial photographs of the SW slope. The
oil of this slope was thus more variegated
an on the NE slope. The variegation of the
oil was increased still further by the numer-
us suslik burrows distributed in chains along
e waterway. On the photographs, these ap-
ear as small light spots, and the entire photo-
raph acquires a striped and finely spotted
haracter (Fig. 3).

The difference in the degree of soil erosion on the short slopes of watersheds between ravines as a function exposition is more marked. The SW slopes have moderately or strongly eroded soils and are dissected by a dense network of shallow waterways or erosion ravines. They stand out in aerial photographs because of their corrugated pattern and lighter tone (Fig. 4) in contrast to the uniform tone of NE slopes.

The dependence of erosion of soil horizons on exposition appears very clearly along ravines. As a rule the slopes of ravines facing NE have some sod and a thin layer of topsoil. The SW slopes are almost devoid of vegetation; the soil on them is unable to develop, and rock is almost continuously exposed along the slopes. This difference in the soil and vegetation of the ravine slopes may be observed on 1:10,000 aerial photographs; it is much more apparent at 1:5,000.

The resistance of soils to erosion depends directly on the properties of the soils, i. e. the structure, texture, humus content and composition, and the adsorption complex of the soils

(2, 5). The principal differences between the soils of the areas investigated are the result of different physical, textural, and chemical properties of the soil-forming parent materials. In addition to the soils developed on the loess-like clay loams described previously, there are also soils based on soft clays and the products of deluvial erosion. The soils on these parent materials are poorly developed, shallow, and subject to severe erosion; they are characterized by a reddish-gray or yellow-gray shallow humus horizon and usually by an angular blocky or a granular blocky structure. These are fine clay loams, low in humus (2.79%-2.64%) and strongly calcareous. They are much more easily eroded than soils developed on loess-like clay loams.

The soil-forming parent materials themselves have a direct effect on erosion and scouring. Loess-like clay loams, the lightest and most porous parent materials, can absorb water much better than the more compact, less porous soft clays. This explains the heavy surface runoff on the clays and consequently the more intense erosion of the soil horizons.

All of this is reflected clearly in the aerial photographs. The areas with poorly developed and strongly eroded soils on soft clays are distinguished by a light gray or white tone on black-and-white aerial photographs. This results from the shallowness of the soil and the high spectral brightness of the soil-forming parent materials (Fig. 5).

Areas with outcroppings of soft clays or wi a slight soil cover are even more strikingly d picted on color aerial photographs, where the correspond to a red-brown or yellowish color (depending on the coloring of the clays). On color airphotos it is possible to trace quite accurately the boundary of soft clay parent materials exposed at the surface or covered with shallow clay loams.

The effect of clays in intensifying soil erosion is felt not only when they constitute directly the soil-forming parent materials but also when they lie a short distance below them In this case rather severe erosion is observed even on slight slopes. The airphoto (Fig. 6) shows a sector of a very flat slope (1%) consis ing of soft clays covered with a thin deluvial d posit of clay loams. The variegated pattern o the photograph confirms the presence here of moderately and strongly eroded soils (light gray and white spots and patterns) along with the mildly eroded dark chestnut soils (the darker tone).

The farming activity of man may also foste erosive processes. In the district investigate which has been under cultivation for many decades, erosion and scouring increased as the slopes were plowed. The most intense erosio is observed in areas under cultivated crops from year to year. Erosion is pronounced als in vineyard districts. This is shown in the airphotos as a lightening of the tone of photographic image.

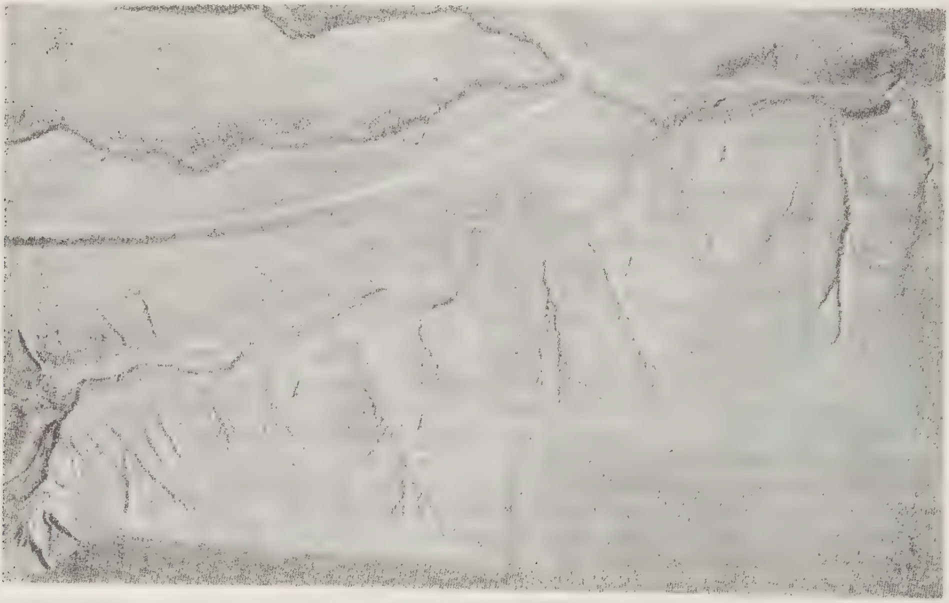

Fig. 5. - A 1:10,000-scale aerial photograph

1 - Primitive strongly eroded soils on soft clays.

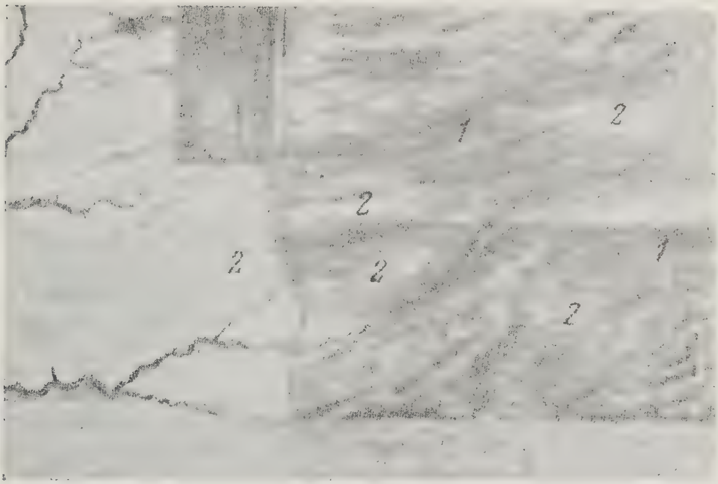

Fig. 6. - A 1:10,000-scale aerial photograph.

1 - Slightly eroded dark chestnut soils; 2 - strongly eroded dark chestnut soils.

The few non-plowed areas under intensive azing, usually close to settlements, are also aracterized by erosion. These areas always ve a lighter tone on aerial photographs than e surrounding areas.

There were hardly any areas with vegeta- on intact in the territory under study, but en the few more or less in grass showed her the complete absence of erosion or an rupt abatement as compared with plowed eas.

As was stated previously, soil-erosion proc- ses were studied with various kinds of aerial otographs. Comparison of airphotos at vari- s scales for identifying eroded soils showed ose at 1:10, 000 to be most useful. On black- d-white airphotos at this scale made with nchromatic film, most forms of linear ero- on waterways, erosion ravines, and gullies), ich are related to the degree of soil erosion a definite manner, are clearly defined. In dition, it is possible to distinguish the dif- rent categories of soil erosion directly from e difference in tone of the image on such rial photographs.

On smaller-scale airphotos (1:25, 000) much the microrelief is either entirely missed or own very indistinctly. This makes it diffi- lt to identify eroded soils from the pattern of e photographic image. But even on these air- otos it is easy to identify the most strongly oded soils.

Airphotos at 1:5, 000 define linear erosion rather great detail. For this reason the otographic image of the individual microrelief elements becomes somewhat indistinct, and hence the boundaries between variously eroded soils are seen less clearly.

The most favorable time for the survey is spring (April-May). When the spring plowing is finished, the soil is rather moist, and contrasts in the surface color of individual plowed areas are greatest.

Compiling Soil Maps Using Aerial Photographs

The final phase of our study of the soil (with emphasis on eroded soils) was the compilation of soil maps for the areas. Soil maps at 1:10, 000 for the areas studied were compiled from data on the nature of the soils obtained during field observations and supplemented with data from analysis of soil samples as well as from interpretation of the aerial photographs.

Geomorphological maps constructed from aerial survey data (1:10, 000 scale) served as the basis for the soil map. Photo-mosaics (1:10, 000 scale) and topographic maps also were used in the preparation of the hypsometric base for these maps. The photo-mosaic served as the planimetric base; the elevations were transferred from the topographic map. By analyzing the photographic image of the relief forms and their quantitative characteristics, obtained with the aid of the simplest stereophotogrammetric measurements, it was possible to draw contour lines at 5-m intervals. The sufficiently detailed picture of microrelief provided by the contour lines together with the photographic image of its elements made it possible to map the gradients, and these maps served as the starting point for constructing the soil maps. The slope maps were very important in locating the outlines of the eroded soils and of areas subject to linear erosion. The outlines of the eroded soils were located by taking into account established relationships between the degree of erosion of the soils and the steepness of the gradients. Erosion of the soils in relation to other factors, as was stated earlier, is shown most clearly on airphotos. Analysis of the photographic image using interpretative indicators for the soils as established in the field studies made it possible to locate the soil outlines and characterize them.

The use of aerial photographs has provided greater detail in the isolation of soil outlines and greater accuracy in locating them than the conventional method of mapping.

Conclusions

1. Soil erosion is widespread in the area surrounding Tsimlyansk reservoir.

The processes of soil wash-out and linear erosion are closely related to the steepness, shape, and exposure of the slopes, to the nature of the soil-forming parent materials, and to the state of the soil surface (plowed or in sod).

2. Eroded soils have a rather distinct appearance on aerial photographs either from changes in the tone of the photographic image or from changes in the nature of the pattern principally by the photographic image of the forms of linear erosion (waterways, eroded ravines, and gullies).

3. Black-and-white, 1:10,000-scale aerial photographs from a spring survey (April-May) are the most useful for the purposes of identifying eroded soils and forms of linear erosion.

4. The use of large-scale (1:10,000) airphotos permits soil maps of the same scale to be compiled. These soil maps show much detail and accurately locate the soil outlines.

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RADICAL IMPROVEMENT OF SOLONETZIC AND PODZOLIC SOILS BY REDISTRIBUTION OF THE SOIL HORIZONS

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The profile of solonetz soils of the chestnut zone divides clearly into the following genetic horizons:

1) An upper humus A Horizon, gray in color and usually 8-18 cm thick. 2) a solonetzic B horizon, brown or chocolate in color, very compact when dry and sticky when wet. This horizon is the main reason for the undesirable properties of solonetz soils. This horizon is 15-20 cm or more thick. 3) A carbonate C Horizon, containing an accumulation of lime (more rarely gypsum), compacted, without humus, and of a light gray color.

Basically there are three different kinds of solonetz soils, differing from one another in external appearance chiefly in the thickness of the upper horizon and the depth of their position relative to the surface of the carbonate (or gypsum-containing) horizon of the soil: crusty-columnar, intermediate, and deep-columnar solonetz soils. In a solonetz soil complex these various kinds occur in discrete spots separated by various kinds of non-solonetzic chestnut soil (1, 2, 5, 8).

The profile of podzolic soils divides clearly into the following genetic horizons: 1) a dark gray A Horizon, consisting of sod or humus; this horizon is the most fertile. 2) a light gray podzolic A_2 Horizon, severely leached, almost completely devoid of humus, and structure-less. This horizon is the main reason for the undesirable properties of podzolic soils. 3) a reddish brown illuvial B Horizon. This accumulates, for the most part, nutrients derived from the upper horizons during podzol formation.

Ordinary deepening of the plowed layer in these soils will only mix part of the infertile podzolic horizon into the cultivated layer. V. P. Mosolov concluded that the plowed layer in podzolic soils must be deepened to mix in a part of the illuvial horizon. In this case a thicker fertile layer may be created in podzolic soils at less expense. To make this deepening of the plowed layer possible, it is necessary to redistribute the genetic horizons in such a way that the most fertile A Horizon remains in place, that the podzolic A_2 Horizon is displaced deeper, and that in its place a portion of the illuvial horizon is substituted (3, 4, 7).

Ordinary deepening of the plowed layer of solonetz soils also may be done only at the cost of mixing a portion of the solonetz horizon into the plowed layer, while the carbonate horizon is not affected by the conditioning and the calcium carbonate of the lime (and gypsum) is not utilized for the self-improvement.

Since the position of the genetic horizons in podzolic and solonetz soils is similar, the means for radically improving them may be one and the same.

For the redistribution of the genetic horizons of the soils a three-layer plow was produced in the All-Union Institute for the Mechanization of Agriculture, first for the radical improvement of podzolic soils and then, with some changes, for the radical improvement of solonetzic soils. In carrying out this task agronomic questions were solved in cooperation with the All-Union Fertilizer, Agricultural Engineering, and Soil-Study Institute, the V. V. Dokuchayev Soil Institute of the Academy of Sciences of the USSR, and the Stalingrad Experiment Station.

As a result of cultivation with the three-layer plow a number of important agricultural improvements of podzolic and solonetzic soils are achieved simultaneously which promote increased fertility. In podzolic soils: 1) the podzolic horizon harmful to agricultural crops is displaced downward and replaced with a portion of the illuvial horizon. This permits us to thicken the cultivated layer at less cost for organic and mineral fertilization; 2) the moisture, nutritional, and aeration regimes of the soil are improved; 3) a general improvement of the cultivated layer is achieved which is most favorable for the growth of agricultural crops.

This treatment has the following effects on solonetzic soils: 1) a marked reduction in the solonetzic characteristics of the upper layer, and the soil becomes more fertile when plowed only once with the three-layer plow; 2) the solonetz and solonetzic horizon, which is impermeable to water, is broken up and redistributed; 3) the necessary condition is created for tilling solonetz soils using their own calcium carbonate from lime (and gypsum).

If solonetzic and podzolic soils are cultivated with the three-layer plow only once, in the course of time the soil becomes compacted, and the moisture, nutritive, and aeration regimes of the soil deteriorate. It is necessary to maintain deep-plowed podzolic and solonetzic soils in the mellow state by means of periodic cultivation without the moldboard. Large areas of complex land with solonetz spots occupying as much as 30% of their surface area have already been converted to arable land and put to agricultural use. Below the cultivated layer in these areas a portion of the impermeable solonetz horizon remained. A portion of the solonetz in these lands has been mixed into the cultivated layer. It is most reasonable to cultivate these lands further by mixing part of the carbonate horizon into the solonetz stratum while at the same time disrupting the impermeable horizon below the cultivated layer. For this purpose a special cultivator without a moldboard is a natural choice; this should lift part of the carbonate (gypsum) horizon into the solonetz layer without bringing it to the surface.

In the non-chernozern zone large areas of podzolic lands have been deep-plowed to mix part of the podzolic horizon into the cultivated layer. The remaining portion stays below the cultivated layer with all its undesirable characteristics intact. It would be most desirable to deepen these lands by mixing part of the illuvial horizon into the podzolic horizon.

On the basis of these requirements, the All-Union Institute for the Mechanization of Agriculture developed a land-improvement cultivator for use in combination with three-layer plows, which in addition has independent importance for the radical improvement of solonetzic and podzolic soils that have long been under cultivation.

Construction of Implements for Radical Improvement of Solonetzic and Podzolic Soils

As was mentioned previously, a set of implements for the radical improvement of solonetzic and podzolic soils was developed on the basis of a principle that is most favorable for agricultural crops, that of the redistribution of the genetic horizons of the soil.

I. The three-layer plow PT-2-30 is a three-layer plow in two sections with a span of 30 cm per section (Fig. 1). Its technical specifications are as follows:

Lateral span of the plow, 60 cm; depth of cultivation, to 60 cm; performance in 10 hours, 2.3 ha; fuel consumption, 70-80 kg/ha; weight of the plow, 1650 kg; number of plow bodies; two sections of three bodies each.

The plow is pulled by a C-80 tractor in first and second gear depending on the depth of cultivation and soil conditions.

II. In view of the fact that the principal tractor used for agricultural purposes in the USSR is the DT-54, the three-layer plow designated PT-40 was produced to work in conjunction with this tractor. The technical specifications of the PT-40 plow are as follows:

Depth of cultivation, 40-45 cm; lateral span, 40 cm; performance, 1.2-1.5 ha in 10 hours; fuel consumption, 40-50 kg/ha; weight of the plow, 1000 kg; number of plow bodies, a single section consisting of three bodies.

III. The soil-improvement cultivator RV-6-35 is an All-Union Institute of Mechanization cultivator with six bodies, each covering a strip 35 cm wide. This cultivator is shown in Figure 2 with ripper blades for reclamation tillage. Its technical specifications are as follows:

Span of the cultivator, 210 cm; bottoms without moldboards and interchangeable ripper blades for 6 positions; depth of cultivation using the bottoms lacking moldboards without loosening, 30-35 cm; depth of cultivation using the ripper blades for reclamation tillage without loosening, 50 cm; performance, 8 ha in 10 hours; fuel consumption, 16-18 kg/ha.

The cultivator is pulled by the C-80 or DT-54 tractors depending on the depth of cultivation and the width of strips.

The techniques of mixing the soil layers with the three-layer plows PT-2-30 and PT-40 involves three bodies arranged sequentially according to depth. The process of mixing the soil layers is considered as if the plowing has already begun. The bottom for turning the first soil layer (humus, cf. Fig. 1, 1), located in the forward part of the section, throws it into the furrow behind on the third soil layer (carbonated or illuvial). Bottom 3, located behind bottom 1 and displaced relative to it toward the right side of the furrow, lifts part of the third layer together with the first layer lying on top of it and moves them aside without turning them. At the same time bottom 2, located to the rear of the section, throws the second soil layer from behind into the bottom of the

[illegible]

[illegible]

[illegible]

[illegible]

Second, instead of cultivating without moldboards it is also possible in the initial pass to use moldboard turning with ordinary plows. Then the shares lacking moldboards are replaced with ripper blades. These are used to introduce part of the third layer into the second and mix them together.

Study of the Shifting of Genetic Soil Horizons with Implements for the Radical Improvement of Solonetz and Podzolic Soils

A basic index of the quality of the work of multi-layer plows is their accomplishment of the given shifting of the genetic soil horizons.

The shifting of genetic soil horizons is studied by dying the soil layers before cultivation. When the genetic soil horizons are already colored differently, there is no need to burden the experiments with differentially dyed layers. Podzolic and solonetz soils belong to this category of soils. After cultivation a cross section is made and the new position of the genetic soil horizons is measured with the aid of a coordinate rod and a meter stick, and it is plotted on millimeter paper. From this diagram it is possible to determine approximately the quantitative shift of the genetic horizons relative to one another (6). But in studies of the shifting of the genetic soil horizons by this method we cannot determine how the soil layers are turned, how far the soil particles are moved from their previous position, or the causes for the mixing of one layer with another, since we cannot be sure that the blades of the implement followed the boundaries between horizons exactly. These deficiencies are eliminated by running the experiments by the coordinate-marker method. This consists essentially in the following: before cultivating, holes are bored to the depth of cultivation and identified markers are placed in them; the position of the markers is measured with a coordinate rod and meter stick. After cultivation the markers are located and their new position measured also with the help of the coordinate rod and the meter stick set up at the previous location.

Figure 3 shows a cross section of the cultivation of medium-columnar solonetz with the PT-2-30 three-layer plow made during Government tests at the Stalingrad Experiment Station in which the color differences between the horizons are utilized. We see from this profile that up to 90% of the humus horizon is located in the upper layer from 0-25 cm deep. The bulk of the carbonate horizon is located from 25-45 cm deep, and the major portion of the solonetz horizon lies between 45 and 65 cm. Both of these horizons are intermixed to a large extent, and this meets the agronomic requirements for the melioration of solonetz soils.

If we study the cultivated profile for the 2-30 three-layer plow made by the coordina
marker method, we see that the first layer
reversed and lies at the surface; the second
drops lower and is turned over; the third la
is raised higher and is not turned over. In
addition, we see how far each of the soil la
is displaced three-dimensionally. It is pro
able to study the movement of the soil layer
both methods. If we use the method of natu
coloration of the horizons, we can determin
position of the genetic soil horizons after cu
tivation. The method of plotting markers p
mits us to determine the shift of the soil lay
independently of the position of the genetic h
zons.

The shifting of the genetic horizons by th
RV-6-35 cultivator equipped with blades lac
ing moldboards is studied by the method of
plotting markers. By this method it was po
ble to determine the size of the shift of the s
particles from their previous position. Fro
study of the cross section of the cultivation
a solonetz soil it was determined that part o
the humus horizon falls into clefts left by the
cutters, but the solonetz and carbonate horizons are hardly shifted in the vertical direction at all. Displacement of the soil to the
right does not exceed 8-10 cm over the whol
thickness of the cultivated layer. Thus the
carbonate horizon is not utilized for self-am
oration in the non-moldboard cultivation of
solonetz soil. Little improvement is shown
also in the water permeability of the solonet
horizon, since the cracks and fissures form
in them by cultivation disappear when wetted
(10).

The shifting of the genetic horizons by the RV-6-35 equipped with ripper blades was studied by the method utilizing the natural coloration of the soil layers.

Figure 4 shows a cross section of the stat
of cultivation after the passage of a cultivato
with blades to mix part of the carbonate hori
into the solonetz horizon. There was no mix
in the upper layer to a depth of 25 cm. The
solonetz horizon between 25 and 40 cm depth
took in soil from the carbonate horizon to th
extent of 40%, and a similar amount of solon
soil appeared at a depth of 35-40 cm. Thus
implements mentioned mixed part of the car
ate soil horizon into the solonetz horizon. I
is also evident from the profile that the impl
ments do not lift the soil over the whole spar
the cultivator. This is the result of an atten
to reduce the drag on the equipment so that t
DT-54 tractor could be used in this operatio
In practice, after several cultivations that
must be repeated periodically as the soil co
pacts, the second and third layers are mixe
and transformed into a uniform soil layer.

From our discussion it is evident that the

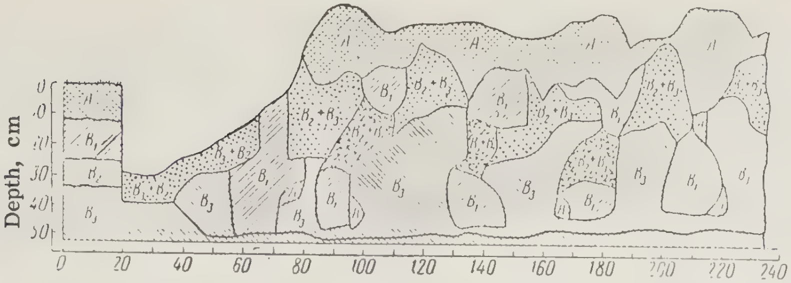

Fig. 3. - Transverse profile of tillage by the three-layer plow PT-3-30.

A - humus horizon; B_1 - solonetzic horizon; B_2 - transitional from solonetzic to carbonate; B_3 - carbonate horizon.

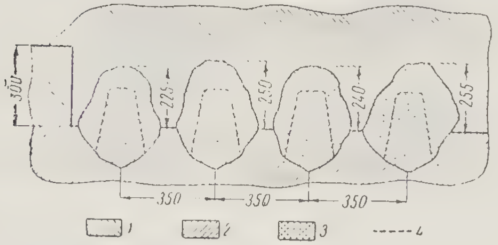

Fig. 4. - Transverse profile of tillage by the soil-improvement cultivator RV-6-35 with with working members to mix the lower and middle soil layers.

1 - upper and middle layers of soil; 2 - lower layer of soil; 3 - mixed portions of the lower and middle soil layers; 4 - outline of the ripper blade.

-improvement cultivator RV-6-35 is suit- for use in conjunction with the PT-2-30 e-layer plow and also may be used inde- ently for radical improvement of solonetz odzolic soils long under cultivation.

he three-layer plow PT-2-30, the PT-40, he soil-improvement cultivator RP-6-35 , RV-6-35) may be used for radical im- ement of solonetz soils not only in the tnut-soil region, but also in the steppe and st-steppe areas of the European USSR and ern Siberia. Thus the Western Siberian ch of the Academy of Sciences obtained ive results from a study of the effect of multi-layer cultivation of solonetz soils in Novosibirsk Region (9). N. V. Orlovskiy obtained favorable results from working solonetz soils by the multi-layer method in Altay Subdistrict.

Instances of heavy downward losses of the humus horizon occur with the use of three-layer plows. The chief cause of these losses is an incorrect depth setting for the first-layer plowshare, which must be determined according to the thickness of the humus horizon of the various types of non-solonetz soils. When the plow is adjusted in this way, a significant portion of the solonetz horizon of crustysolonetz soils and an insignificant part thereof in medium solonetz soils will be introduced into the upper layer, but at the same time almost all the humus horizon present in the area will be found in the upper layer to a depth of 25 cm. Also, solonetz soils mixed into the upper layer will exist under conditions favorable for cultivation and their harmful effects will be eliminated relatively fast.

Conclusions

1. The most suitable method for the radical improvement of podzolic and solonetz soils seems to be the redistribution of genetic soil horizons in such a way that the humus horizon, which is the most fertile, is kept at the surface but the podzolic and illuvial horizons in podzolic soils, as well as the solonetz and carbonate horizons in solonetz soils, change places.

2. The depth of occurrence and the thickness of the genetic horizons of podzolic and solonetz soils are similar. Consequently, the means utilized for their radical improvement may be the same.

3. As a result of experiment, implements have been developed to put into effect new methods for the basic improvement of podzolic and solonetz soils: the PT-2-30 and PT-40 three-layer plows and the RV-6-35 soil-improvement cultivator without moldboards. The three-layer plows are recommended for the basic improvement of strongly podzolic soils and soils of the chestnut zone containing solonetz in excess of 30%.

The soil-improvement, non-moldboard cultivator RV-6-35 is an implement that works in conjunction with the PT-2-30 and PT-40 three-layer plows, for mixing two soil layers at depth while keeping the top layer at the surface. It also has independent importance for the radical improvement of slightly and moderately podzolic and chestnut solonetz soils having solonetz contents below 30%.

4. The PT-2-30 and PT-40 three-layer plows are all-purpose plows of a new type. In the three-layer version they can be used for plowing soils while keeping the humus layer at the surface; and in the two-layer version, for plowing chernozem soils where the humus layer is turned under.

These implements are tested under experimental production conditions and proved to be completely satisfactory for the purposes intended.

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OVEMENT OF Na^+ AND SO_4^{--} IONS WITH WINTER LEACHING

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The purpose of this experiment was to in-
tigate the laws governing the solution and
vement of Na^+ and SO_4^{--} during winter leach-
of sodium sulfate solonchaks.

A number of investigators (1, 3, 4, 5, 6, 7, 8,
0, 14, 15, 16, 17 and others) have set forth
basic laws governing the movement of salts
e soil during leaching. However, the mecha-
n of the process of desalinization itself
oils during leaching has not been investi-
ed adequately and this has been noted by
y authors (3, 11 and others).

t has been established that the solubility of
SO_4 depends on the temperature and de-
ases appreciably as the temperature drops
ole 1).

n accordance with this law many soil scien-
s (3, 7, 12 and others) are of the opinion
the Na_2SO_4 present in the soil when the
perature drops to 0°C precipitates out of
tion in the form of crystals of mirabilite
SO_4 x 10 H_2O) and for this reason the proc-
of its removal is slowed down.

t the same time prolonged trials of irri-
ed farming for many regions of Central
indicate the high effectiveness of winter
hing (even when an ice crust forms on
irrigated fields). For this reason, at
suggestion of V. A. Kovda, we decided to study
problem under winter conditions.

Objects and Methods of Investigation

he experiments were conducted at Bukhara
s under drainage conditions at the experi-
tal station of the All-Union Scientific Re-
ch Institute of Cotton Culture and adjacent
e Kalinin Kolkhoz Station. These sites
located on the second flood plain terrace
e Zeravshan River. This part of Bukhara
s was a region in which the flow of ground
r was impeded.

At both sites the observations were conducted on specially selected plots in which the soils were (in accordance with the classification of Rozanov [13], adopted by us) old-irrigated, strong solonchak-like meadow sierozems and meadow solonchaks (clay-loams) with ground water near the surface (at the experimental station, 2 m down; at the Kolkhoz, 1.5 m down).

At the experimental station, Plot No. 1 was selected in a field where melons were being grown; No. 2, in the Kolkhoz, in a cotton field. The size of these plots was 50 x 20 m; within each of them four 1 x 1 - meter areas were chosen for the observations. The small areas were located a uniform distance from the collector (25 m) and 10 m part.

In order to determine the effects of fall plowing and leaching on the movement of salts in the experimental areas at various times, we determined the moisture content and temperature of the soil, the salt concentration in the water extract and in the soil solution, and the depth and the degree of mineralization of the ground water. We also determined the bulk density (1.5 for clays, 1.40 for clay loams), the maximum water capacity (18%-28%), and the rate of water intake in the uppermost meter of the clay layer (4.3 cm/hr).

In both plots the type of salinity shows features characteristic for the whole oasis: the surface salinity is of a sodium sulfate nature with significant quantities of Mg^{++} in the make-up of the salts and with a small Ca^{++} content; gypsum was almost absent in the soil profile, while the carbonate content ($CaCO_3$) amounts to 15%-25%.

We averaged the data for each horizon (Table 2). The conclusion made previously is confirmed also by the index of accuracy (P) and the size of the mean square deviations (δ).

Table 1

Solubility of Na_2SO_4 in water at various temperatures[a]

Temperature, °C	−1.2	0	10	15	20	25	33.4	34
Na_2SO_4, %	3.85	4.63	8.26	11.66	16.02	21.74	33.5	35.5

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[a] Data from Chemical Handbook, 1952, Vol. 3.

Results of the Investigation

In Plot No. 1 in the late-summer period (September 17, 1956) in the layer from 0-10 cm the salt content (according to water-extract data) amounted to 32 meq; SO_4^{--}, 14 meq; Na^+, about 9 meq; and Mg^{++}, 6 meq. In the layer from 10-20 cm an abrupt decrease in salt content to 9.8 meq was observed; the middle portion of the profile (40-100 cm) was weakly saline because it is coarser in texture; in the layer from 120-140 cm we observed a low accumulation of salts, and below this toward the ground water a gradual decrease in salinity.

The concentration of the soil solution in the layer from 0-10 cm exceeded by 10 times that of the ground water; the over-all salt content was 50.6 g/l as against 6 g/l in the ground water; the SO_4^{--} content was 32.6 g/l as against 3.4 g/l; and the Na^+ content was 8.4 g/l as against 1 g/l.

In agreement with these findings were the data on the moisture profile and temperature variations with soil depth for the same period. The upper layer was quite dry (the field moisture content 9%, and the temperature about 26°C). Below this we observed a steady increase in moisture and a gradual decrease in temperature (Table 3).

The naked eye did not detect salt crystals on the surface of the soil, but microscopic study revealed crystals of tenardite (anhydrous sodium sulfate) (Fig. 1).

Between November 15th and 20th we carried out fall cultivation to a depth of 28 cm, on both plots with a plow and attached harrow. On Plot No. 1 this showed a significant effect on the migration of salt solutions (no observations were made on Plot No. 2 for this period). As is evident from Figure 2, on November 25-26 the accumulation of salts in the upper soil layers in Plot No. 1 was distributed equally between the two layers from 0-10 and from 10-20 cm. In November, as compared with the late summer, the SO_4^{--} content in the layer from 0-10 cm decreased to 8.3 meq; that of Na^+ to 4.3 meq. In the layer from 10-20 cm, on the other hand, we noted an almost two-fold increase in salts.

A similar picture was obtained for the soil solutions. In November in the layer from 0-10 cm the concentration of the soil solution decreased to 30 g/l; the SO_4^{--} content to 20; and the Na^+ content to 4.2 g/l. In the layer from 10-20 cm, the concentration of salts in the soil solution was markedly increased; the SO_4^{--} content increased to 21, and that of Na^+ to 6.4 g/l.

After fall cultivation a significant decrease in chlorides was observed in the soil solutions, especially in the upper layers of the soil. Here we considered the fact that the moisture content of the upper layers at this time had increased greatly — from 10%-12% to 18%-19%. Since there had been no precipitation during the entire fall and even at the beginning of winter, the increased moisture content in the upper layers of the soil could have been due only to the decreased temperature and the reduced evaporation associated therewith. In November the capillary fringe had risen to the surface of the soil itself, and in the layers 0-10 and 10-20 cm the field moisture content constituted about 70% of the maximum water capacity. At this time the moisture deficit for a layer 1 m down in both tracts amounted to about 260 m³/ha. In Plot No. 2 the status of salinity is shown only for November 25, 1956; here the salinity is higher than in Plot No. 1 (Fig. 3).

From December 6-11 in Plot No. 2 leaching was done at a rate of 6000 m³/ha of water. It took place at an air temperature of +10°C and a soil temperature (in the layer from 0-10 cm) of + 6°C. (In Plot No. 1 the leaching took place later and in colder weather). The first steady rain of the winter fell on December 12, and on December 13 there was an abrupt drop in the temperature of the air from 10°-2.5°C, and an unprecedentedly cold winter for Bukhara began.

After this, when the entire leaching amount had passed through, an additional 1,000 m³/ha of water was added to the irrigated fields, so that the soil surface would be covered with an ice layer. Since the air temperature dropped rapidly and at night reached -5°C, in the morning an ice crust was present on the plot.

It is known that measures of this sort are

Table 2

Variation in the content of water-soluble salts and SO_4^{--} in a meadow solonchak before and after flushing, September 17, 1956

Depth, cm	Arithmetic mean (M)		Deviation from arithmetic mean								Mean square deviation (σ)		Index of accuracy (P)	
			Sites											
			1		2		3		4					
	SO_4	Total ions	SO_4	Total ions	SO_4	Total ions	SO_4	Total ions	SO_4	Total ions	SO_4	Total ions	SO_4	Total ions
0—10	0.674	1.065	−0.035	−0.070	+0.100	−0.086	+0.070	+0.094	−0.066	+0.062	0.073	0.083	5.3	2.4
10—20	0.183	0.327	+0.055	+0.075	+0.030	−0.046	+0.001	−0.001	−0.025	−0.024	0.036	0.050	9.8	7.5
20—40	0.144	0.269	−0.013	−0.033	−0.008	−0.010	+0.001	−0.005	+0.005	+0.001	0.008	0.020	2.7	3.7
40—60	0.077	0.170	−0.059	−0.085	−0.006	+0.006	+0.037	+0.051	+0.015	−0.032	0.040	0.057	2.6	11.7
60—80	0.053	0.126	−0.031	−0.037	−0.003	+0.043	−0.009	−0.022	+0.008	+0.018	0.018	0.035	9.3	4.0
80—100	0.062	0.136	−0.018	−0.026	−0.021	+0.037	+0.009	+0.005	−0.014	−0.18	0.017	0.026	12.9	2.9
100—120	0.098	0.200	+0.050	+0.097	+0.016	+0.020	+0.011	+0.011	−0.076	−0.128	0.030	0.057	15.3	4.0
120—140	0.178	0.334	−0.008	+0.027	+0.063	+0.068	+0.020	+0.027	−0.077	−0.136	0.038	0.045	10.6	3.0
140—160	0.212	0.380	−0.042	−0.052	+0.039	+0.043	+0.007	+0.012	−0.006	0.017	0.039	0.034	9.4	2.5
160—180	0.242	0.273	−0.064	+0.016	+0.055	+0.181	−0.015	+0.074	+0.024	+0.142	0.048	0.037	11.3	4.6
180—200	0.152	0.280	−0.034	−0.048	+0.014	+0.013	+0.002	+0.008	+0.031	+0.031	0.021	0.029	7.2	1.8

widely practiced in Central Asia. It seemed very important to us to determine what would be the temperature change along the soil profile and how the salts would be distributed under this ice crust.

In Plot No. 1 a leaching was undertaken in January, during a short warmer period (January 15-20, 1957). The average daily air temperature during these days ranged from + 2.5° to -2°C. The temperature of the upper layer of the soil ranged from + 0.6° to +3.8°C. For three days the area was given about 4,000 m^3/ha of water. When the leaching was finished, it was then flooded with water to the extent of 1,000 m^3/ha. Thus the leaching was carried out at rather low air and soil temperatures.

Observations made on January 28th and February 2d on the temperature in Plot No. 1 showed the following: under the 5 cm ice crust and moist soil there was a space with a temperature above O°C, which was also the temperature of the moist soil. At the same time in an adjacent plot with uncovered soil, the temperature of the upper layer reached -3°C (January 28) and -1°C (February 2).

In Plot No. 2 temperatures were observed on January 10, four weeks after leaching. Here a layer of ice 15 cm thick had formed, close to the soil. The upper 10 cm layer of the soil had a temperature of -2°C. The layer from 10-20 cm had a temperature of -1°C, and in the layer from 20-40 cm the temperature rose sharply to +3°C. Lower down the temperature increased as follows: +4.1°, +4.8°, and +5.0°C. In an area without an ice crust, lower temperature readings were found for the same depths: +2°, +2.7°, and +3.2°C. Below the first meter, in both areas, the difference in temperature readings diminished (Table 4).

The experiments conducted showed that as a result of fall plowing and leaching, the soil in both plots was freshened for more than 1 m down. This is evidenced both from water-extract data and from soil-solution data, while in Plot No. 2 boring by layers was carried out four weeks after leaching, on January 10; and on Plot No. 1, after two weeks, on February 2. As is evident from Figure 2, in Plot No. 1, in the layer from 0-10 cm the SO_4^{--} and Na^+ contents were reduced by 9-10 times as compared with the summer. (SO_4^{--}, from 14-1.4 meq; Na^+, from 9.8-1 meq). In the layers from 10-20 cm and from 20-40 cm the quantities of salts decreased by approximately twice; and in the middle and lower sections of the profile, by an average of 1.5 times.

An appreciable desalinization was noted also in Plot No. 2 (Fig. 3). In the layer from

Table 3

Moisture and temperature changes in the soil in Plot No. 1

Depth, cm	Field moisture content %	Temperature, °C	Field moisture content %	Temperature, °C	Field moisture content %	Temperature, °C
	Sept. 17, 1956		Sept. 25, 1956 (after fall plowing)		Feb. 2, 1957 (after leaching)	
0—10	9.1	25.8	18.7	0.7	21.9	0.5
10—20	12.8	24.4	18.2	1.3	20.5	0.8
20—40	14.0	24.3	19.7	not det'd.	19.2	1.2
40—60	15.0	24.1	18.3	4.7	19.3	2.0
60—80	16.7	24.1	22.4	—	19.9	2.5
80—100	17.2	23.9	20.0	6.0	21.1	3.2
100—120	20.8	23.4	20.1	not det'd.	21.3	3.8
120—140	20.5	23.0	20.4	"	23.1	4.5
140—160	20.3	22.6	20.5	10.9	24.1	5.2
160—180	23.0	22.5	22.6	not det'd.	not det'd.	not det'd.
180—200	22.3	21.9	not det'd.	"	"	
Ground water	—	19.3	—	14.3	—	7.5

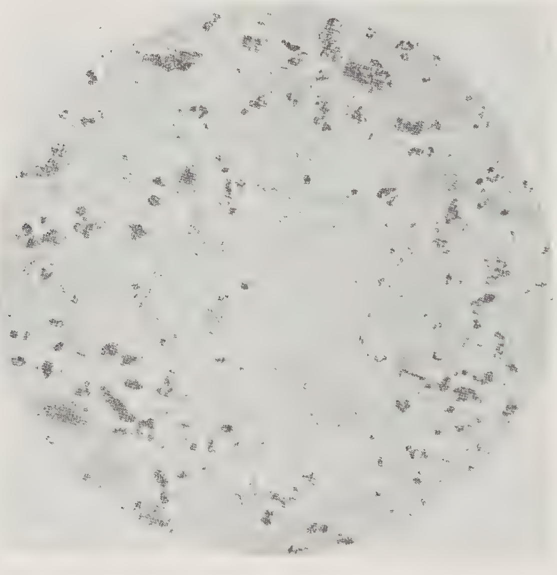


Fig. 1. - Microphotograph of a soil (meadow solonchak, layer from 0-2 cm). Photo by I.I. Feofarovaya.

0-10 cm the SO_4^{--} content decreased to 3.5 meq (as against 24.9); and the Na^+ content, to 2.6 meq (as against 17).

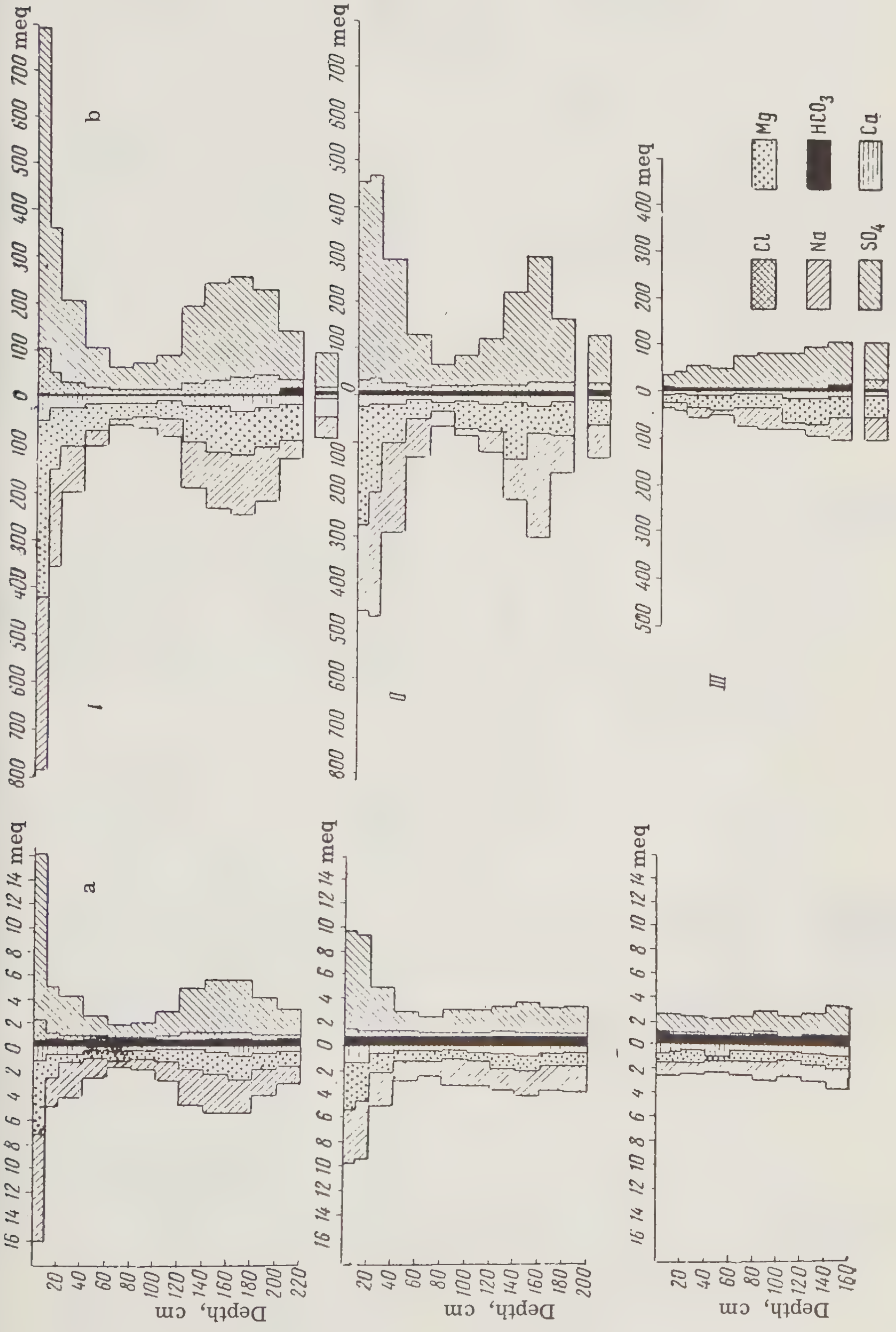
In Table 5 are shown the salt contents by layers, calculated for both plots for two dates: before and after leaching. These data also confirm the conclusion reached previously.

From what we have stated previously it follows that leaching at minimum soil-temperature readings (both at the time of leaching and in the succeeding period) effect a rapid movement of sodium sulfates and removes them fro the upper soil layers.

It was also important that we investigate the effect of leaching on the exchange capacity and content of exchangeable Na^+. It was determined that leaching did not cause a notice-

Fig. 2. - Effect of fall plowing and leaching on desalinization of meadow solonchak in Plot No. 1.

a - from water-extract data; a - from soil solution data. I - in the late summer period (September 7); II - after fall plowing (November 25); III - after leaching (February 2).



able change in the exchange capacity a in the content of exchangeable Na+ (Ta 6).

In Plot No. 1 the total amount of s (total of ions) leached from 0-160 cm 22.8 metric tons/ha, of which 16.7 me tons/ha were SO_4^{--}, and 5.4 metric to were Na^+. In Plot No. 2, 76.5 metric ha of salts were removed from the sa layer; of this 41.2 metric tons/ha wer SO_4^{--}, and 19.2 metric tons/ha were I

A moist soil sample taken in the fi when it was cold was divided into two parts. One part was squeezed in a pr in a cold chamber at the same tempe ture that existed in the soil when this sample was taken (+2°, -2°C). The sec portion was left for 24 hours in a cha with a temperature of +16° to +18°C, then squeezed in the press. A compar of the content in each of the individua components of the solution (SO_4^{--}, Na^+, etc.) squeezed out under warm and co conditions showed that the discrepancy not exceed the ordinary deviation betw parallel determinations (Table 7).

In this way soil solutions were ext from samples of solonchaks from virg gions, in which the concentration of s sulfate exceeded 70-80 g/l. Crystals o mirabilite did not precipitate when the pressed soil solutions were allowed to stand for 10 days at a temperature bel 0°C.

We find an explanation for this phe menon in a recent work of Soviet salt scientists. In the monograph of Bergm and Luzhnaya (2) it is shown that a la number of solutions of a salt system the sulfate-sodium type fall in the regi of metastable (unstable) equilibria and su saturated solutions. In the latter, the highly concentrated brines of sodium su fate (6-80g/1) may be found at a low temperature (from +5 to -0.5°C).

Thus the investigations conducted ar in complete conformity with the irriga practice of several regions of Central Asia. They confirm the effectiveness a soundness of winter leaching of solonch soils, including solonchaks of the sulfa magnesium-sodium type.

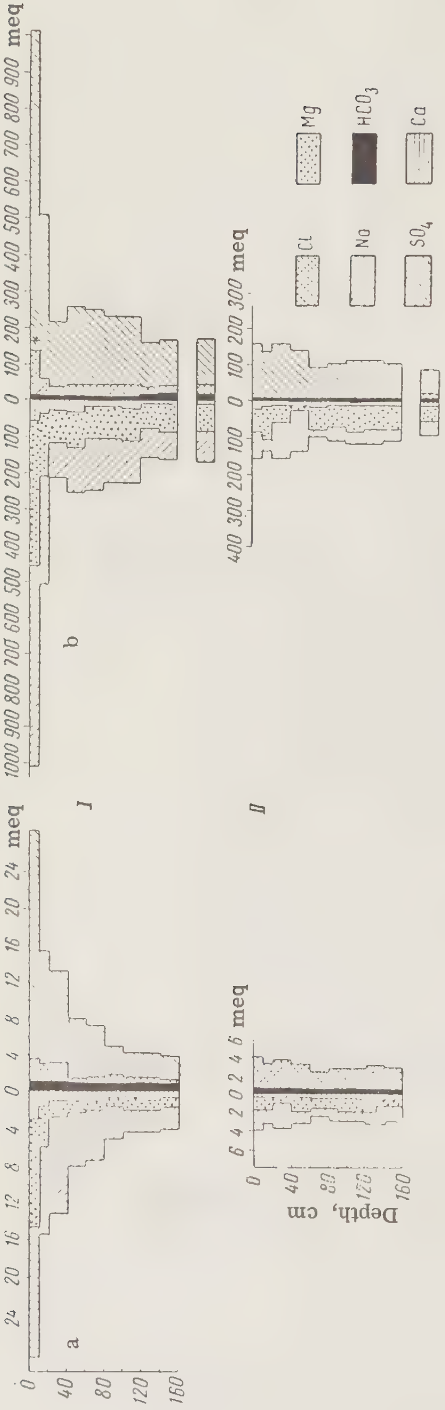


Fig. 3 - Effect of leaching on desalinization of meadow solonchak in Plot No. 2.

a - from water-extract data; b - from soil solution data. I - after fall plowing (November 25); II - after leaching (January 10).

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Table 4

Soil temperature after leaching, Plots No. 1 and 2

Depth, cm	Date	Temperature			Date	Temperature			Remarks
		Air	Soil			Air	Soil		
			In plot without ice layer	In leached plot			In plot without ice layer	In leached plot	
Plot No. 1									
0—10	Jan. 28	—7.8	—3	+1.0	Feb. 2	—3	—1.1	+0.5	
10—20			0	+1.2			—0.6	+0.8	Under the ice crust soil did not freeze. Between it and the soil was an air layer, with a temperature above 0°C. Snow layer, 5 cm thick; ice crust, 5 cm thick.
20—40			+1.2	+2.1			+0.8	+1.2	
40—60			+2.1	+2.6			+1.2	+2.0	
60—80			+2.4	+2.7			+2.1	+2.5	
80—100			+2.6	+2.8			+2.9	+3.2	
100—200			—	—			+4.0	+3.8	
120—140			—	—			+4.5	+4.5	
140—160			—	—			+5.1	+5.2	
Ground water			—	—			+7.5	+7.5	
Plot No. 2									
0—10	Jan. 10	—1.5	0	—2	Not determined				
10—20			+0.2	—10	„		„		Soil layer from 0-10 cm thoroughly frozen; above was a snow layer 5 cm thick and an ice layer 15 cm thick.
20—40			+1.0	+3.0	„		„		
40—60			+2.0	+4.1	„		„		
60—80			+2.7	+4.8	„		„		
80—100			+3.2	+5.0	„		„		
100—120			+5.1	+5.1	„		„		
120—140			—	—	„		„		
Ground water			+7.0	+7.0	„		„		

Table 5

Effect of leaching on the desalinization of meadow solonchak. Salt content, metric tons/ha

Depth, cm	Plot No. 1						Plot No. 2					
	Before leaching			After leaching			Before leaching			After leaching		
	Total ions	SO_4^{--}	Na^+	Total ions	SO_4^{--}	Na^+	Total ions	SO_4^{--}	Na^+	Total ions	SO_4^{--}	Na^+
0—10	14.9	9.4	2.8	2.5	0.9	0.3	26.5	16.7	5.5	4.1	2.4	0.8
0—20	4.6	2.6	0.8	2.4	1.0	0.3	14.3	8.3	3.0	3.2	1.7	0.6
0—60	31.8	18.2	5.5	14.1	5.8	1.9	80.1	45.9	18.4	22.4	12.5	4.5
0—100	7.3	3.2	0.9	10.3	4.3	1.7	22.9	11.3	5.2	9.8	4.7	1.4
0—100	39.1	21.4	6.4	24.4	10.2	3.5	103.0	57.2	23.6	32.2	17.2	5.9
0—160	25.6	13.7	5.2	17.5	8.2	2.7	23.3	10.5	4.6	17.6	9.3	3.0
0—160	64.7	35.1	11.6	41.9	18.4	6.2	126.3	67.7	28.1	49.8	26.5	8.9

Table 6

Exchange capacity and content of exchangeable Na^+ with leaching
(Analyst, A. I. Zelenova)

Depth, cm	Before leaching					After leaching				
	Exchg. cpty. meq.	Exchangeable cations, meq/100 g of soil		% of total exchangeable cations		Exchg. cpty. meq.	Exchangeable cations, meq/100 g of soil		% of total exchangeable cations	
		Ca+Mg	Na	Ca+Mg	Na		Ca+Mg	Na	Ca+Mg	Na
Plot No. 1										
0—10	6.73	6.30	0.43	93.6	6.4	6.62	6.20	0.42	93.7	6.3
10—20	6.47	7.09	0.38	94.9	5.1	7.26	6.79	0.47	93.5	6.5
20—40	7.74	7.25	0.49	93.7	6.3	7.69	7.19	0.50	93.5	6.5
40—60	5.66	5.53	0.13	97.7	2.3	5.66	5.48	0.18	96.8	3.2
60—80	5.81	5.58	0.23	96.0	4.0	5.91	5.63	0.28	95.3	4.7
Plot No. 2										
0—10	7.70	7.35	0.35	95.5	4.5	7.80	7.44	0.36	95.4	4.6
10—20	7.71	7.18	0.53	93.1	6.9	7.69	7.20	0.49	93.6	6.4
20—40	7.46	7.11	0.35	95.3	4.7	7.50	7.12	0.38	94.9	5.1

Table 7

Salt content in the soil solution taken from the same sample at various temperatures, g/l (meadow solonchak)

Profile No.	Depth, cm	Date sample taken	moisture %	Soil temp, °C	HCO_3, total	Cl^-	SO_4^{--}	Ca^{++}	Mg^{++}	Na^+
5	0—10	Jan.9,1957	18	— 1.5	1.22	4.15	43.93	0.50	5.62	13.00
	"	"	18	+18	1.20	4.21	43.36	0.48	5.57	12.90
2	0—10	"	19	— 1.0	0.38	0.89	22.17	0.49	3.16	4.80
	"	"	19	+16	0.38	0.81	21.81	0.51	3.09	4.50
5	0—10	Jan.18,1957	20	— 2.0	0.41	4.91	50.78	0.35	5.39	17.50
	"	"	20	+16	0.40	4.92	49.98	0.40	5.41	17.02
6a	0—10	Jan.10,1957	21	— 2.1	0.43	5.95	57.27	0.54	5.19	21.01
	"	"		+17	0.44	6.01	57.71	0.60	5.88	20.85
7a	"	"	20	— 1.5	0.49	4.63	55.37	0.64	4.43	20.59
	0—10	"	20	+18	0.50	4.63	55.41	0.68	4.55	20.88

In salts

Profile No.	Depth, cm	Soil temp, °C	$Ca(HCO_3)_2$	$CaSO_4$	Na_2SO_4	$MgSO_4$	$MgCl_2$
5	0—10	—1.5	1.7	0.2	40.2	20.8	5.6
2	0—10	—1.0	0.5	1.2	14.8	14.1	1.2
5	0—10	—2	0.6	0.7	52.7	18.4	6.6
6a	0—10	—2.1	0.6	1.4	64.9	15.6	8.0
7a	0—10	—1.5	0.6	1.6	63.6	14.1	6.2

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COMPARATIVE EVALUATION OF VARIOUS ASSAY METHODS FOR EXCHANGEABLE BASES

M. M. GODLIN

To determine the total exchangeable bases Kappen-Hilkovits have proposed a method of displacement of the exchangeable bases by acid hydrogen, wherein 0.1 N HCl is used at the rate of 125 ml per 25 g of soil.

The quantity of exchangeable bases as determined by the Kappen-Hilkovits method with rare exceptions is too low and does not agree with the results of determinations by the generally recognized Gedroyts method (1). This lack of agreement is explained by the close ratio (5:1) between the volume of acid and the weight of soil.

With this situation in mind, evidently the All-Union Institute of Fertilizers, Agricultural Chemistry, and Agricultural Soil Science (VIUAA) (3) increased the ratio between acid and soil to 10:1. On the other hand, this resulted in amounts of exchangeable bases for some of the soils that were too high in comparison with the totals obtained by the Gedroyts method. This excess amount of exchangeable bases obtained when the soil was treated by twice the volume of 0.1 N acid may be explained by the partial destruction of the aluminum silicate fraction of the soil and the entrance of its bases into solution.

As early as 1938, when we were using acids of various concentrations for the preparation of soils for particle-size analysis with different ratios between the volume of acid and the weight of soil, we were convinced that the maximum useful concentration for displacing the exchangeable bases without breaking down the aluminum silicates is 0.05 N HCl at the rate of 200 ml for 10 g of soil (2), i. e., acid at half the concentration but twice the volume used in the VIUAA version of the method (Table 1).

With the considerations outlined previously in mind, as well as the experimental data obtained, we carried out an experimental study of the three modifications mentioned on the methods of determining the total exchangeable bases for eight samples of different soi groups. In these soils Ca^{++} and Mg^{++} determined by the ammonia method of Gedroyts. The results of these determinations are presented in Table 2. On th basis of the results obtained, the following conclusions may be drawn:

1. The value obtained for the total e changeable bases by the Kappan-Hilkovits method was too low in all the soils analyzed. When we used the VIUAA metho a larger quantity of bases was obtained four or five cases than by the direct d termination of Ca^{++} and Mg^{++} with the method of Gedroyts.

2. For almost all the soils studied th best agreement between the values for t exchangeable Ca^{++} and Mg^{++} obtained by the Gedroyts method was found when we used Godlin's modification for determinin the exchangeable bases. Evidently this c be explained by the fact that 0.05 N acid causes almost no breakdown of the collo dal complex of the soil (Gedroyts had already noted this in his work) and that the volume of acid recommended (200 ml at this concentration is sufficient to replace the exchangeable bases from 10 g of soil.

Let us mention that in moderately sol etzized chernozem no exchangeable sodiu was found, and this resulted in a discrep ancy in the values.

3. The results obtained and the theoretical premises permit us to recommen the treatment of cohesive soils with 0.05 N HCl at the rate of 200 ml per 10 g of soil for the determination of the total ex changeable bases (S). In the case of coar sand and sandy loams low in exchangeab

Table 1

arisons of the total exchangeable bases by various methods

oil	Exchangeable bases, meq			
	By the Kappen method	By modification of		Ca^{++}and Mg^{++} by Gedroyts
		Godlin	VIUAA	
nary rnozem, zhevsky 'S	41.69	46.87	50.34	47.04

, the relative weight of soils may be ased to 20 g.[1]

alytical procedure: To a flask containing of clay and clay loam soil or 20 g of sandy oarse sandy loam are added 200 ml of N HCl. The contents of the flask are en on a rotator or by hand for one hour.

After standing 15-20 hours the contents of the flask are shaken and filtered through a folded filter. The first portion (20-30 ml) of the filtrate is discarded and from the remaining filtrate 250-ml portions are taken for titration. Before titration the liquid is boiled 3-5 minutes to expel CO_2, and then is titrated in the hot state with a 0.1 N solution of NaOH with phenolphtalein as the indicator until a non-fading faint pink color is obtained. Simultaneously, 50 ml of 0.05 N HCl heated to boiling should be titrated against a 0.1 N solution of NaOH (a blank determination).

We calculate the total exchangeable bases by the formula:

$$\frac{4\ (a-b)\ \ N \times 100}{H}$$

equals meq in 100 g of soil.

Table 2

Determinations of exchangeable bases in soils by various methods

Soil	Exchangeable bases, meq			
	By the Kappen method	By modification of		Ca^{++} and Mg^{++} by Gedroyts
		Godlin	VIUAA	
ck, coarse clay loam chernozem; Nosovka, ernigov region	14.9	15.1	15.5	15.1
ck, medium clay loam chernozem; Drabovo, erkassy region	24.0	25.4	28.1	25.3
ck, heavy clay loam chernozem; Pervukhino, my region	22.0	24.2	24.5	23.9
ck, clay chernozem; Karlovka, Poltava gion	37.7	42.7	43.8	43.0
linary chernozem; Sinel'nikovo, Dnepropetvsk region	28.7	33.1	33.6	33.3
k chestnut soil; Askaniya Nova	37.0	42.1	43.8	41.6
akly solonetzized chernozem; Pereyaslavhmel'nitskiy, Kiev region	19.0	19.6	19.9	18.5
y forest soil; Nemirov, Vinnitsa region	14.2	15.2	15.3	15.1

In this formula: a is the number of milliliters of alkali used to titrate 50 ml of acid (blank determination); b is the quantity of the same alkali used to titrate 50 ml of the filtrate; 4 is the factor used to convert the volume of the filtrate to a weight (200 ml); N is the normality of the alkali; H is the weighed portion of soil; and 100 is the factor giving the total of exchangeable bases (S) in meq for 100 g of soil.

If the acid solution used is exactly 0.05 N, and the alkali is 0.01 N, and if the weighed amount of soil is exactly 10 g, then to calculate the total exchangeable bases we may use the following abbreviated formula: 100-4 b = S in meq for 100 g of soil.

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isfactory results are obtained with the Kappenvits method only for the more cohesive soils. oarse sand and sandy loams, especially if they an acid reaction, negative values for the content hangeable bases are obtained in a number of with this method. Hence the method cannot ed at all for these soils. Evidently, this apalso to the suggested method of Godlin, which to be checked.

In this formula b is the amount of 0.01 N alkali used to titrate 50 ml of filtrate.

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REVIEW

ILS OF JAPAN (With a general map of the soil groups of Japan on a scale of 1:8,000,000)
Iiutaka Kamoshita. Publication of the National Institute for Agricultural Sciences, Tokyo,
an 1958.

The book under review (with an appended
ieral soil map of Japan) was prepared by
. Iiutaka Kamoshita the Director of the De-
tment of Soils and Fertilizers. This work
nmarizes material on genesis and geography
Japan soils since 1886. As the first summary
rk on the soils of Japan, this book is of great
erest for soil scientists of various countries
o are interested in the genesis and cartography
soils. The great merit of this work, from
point of view, lies in the fact that the soil
ssification proposed by the author is based
recognition of soils as an independent natural
ly. The peculiarities of the genesis of this
ly are expressed in the formation of a specific
rphological profile. Such an approach to soil
mation and to soils is new for Japan and is
dence of the creative utilization by the soil
entists of Japan of the genetic principles of
kuchayev's soil science. We should keep in
nd that until 1935 agrogeological soil science
nciples played the dominant role in Japan.
er the Second World War the tendency among
soil scientists of Japan was to map the soils
Japan based on principles adopted in the
ited States based on soil series. Lately,
ietic soil science is beginning to acquire a
re firm position in Japan.

The author first examines the soil formation
tors, reviews the history of soil studies and
n describes soil groups in Japan. There are
chapters in the book. As an appendix there
a general soil map of the soil groups of
an on a scale of 1:8,000, 000 prepared by
author.

After a very brief account of basic data on
general geography of Japan (Chapter I), the
hor brings to light in Chapter II the soil for-
tion factors. Following G. Stremme the
hor distinguishes seven soil formation fac-
s, namely: vegetation, water, topography,
ent material, human factor, climate, and
e. From the nature of the effect of one or
other factor on the soil profile these factors
are subdivided into direct and indirect. The effect of direct factors can be immediately observed in the soil profile. In this category the author places most soil formation factors: vegetation, water, topography, parent material and human activity. The other two factors — climate and time — are associated with indirect factors. Addition of ground waters to soil formation factors answers not only the presently existing tendencies abroad (G. Stremme and others) but also several works in the USSR (A. A. Rode). This is the result of extending investigations into the fields of study of the water regime of soils and its effect on soils.

The author considers the soil formation factors very briefly and points only to their basic peculiarities. Especially typical for the climate of Japan is the predominance of precipitation over evaporation and the monsoon character of their distribution. Therefore, in all the soil groups of Japan the leaching processes occur intensively. From our point of view, no less important is the large amount of precipitation or rainfall found in most parts of Japan (1008-2586 mm). In areas bordering the shore of the Pacific Ocean there exists a clearly expressed summer maximum in precipitation distribution. Thus, along with an intensively expressed leaching process we should also expect the development of gleying phenomena, even under dissected relief conditions. Iu. A. Liverovskiy and L. P. Rubtsova point to the gleying signs as typical of the soils of the Soviet Far East which have climatic conditions similar to Japan.

There are in Japan three latitudinal vegetation zones — the cold boreal zone of coniferous forests, the temperate zone of deciduous forests (oak, maple, chestnut, etc.), and the humid zone of evergreen forests (pasaniia, camphor, etc.). A zonal group of soils called by the author a vegetation group corresponds to each bioclimatic zone. These groups of soils are podzolic, brown forest, and red soils. The well expressed zonality is noted by the author only for the more or less level areas. Mountain areas are not mentioned.

The effect of ground and other waters on soils, as the author states, is of essential importance for Japan. This is explained by the fact that the basic cultivated areas are located on the most leveled strips and on the lower absolute elevations. Half of the cultivated area is under rice.

Besides the soil-ground waters, the river waters (by adding suspended matter and its influence on ground waters) have a great effect upon the soils.

The effect of topography on soil formation, in the author's opinion, is evidenced by the effect of topography on the drift, transfer and redeposit of the weathering products of parent (mostly hard) materials. Thus, in the mountains in the presence of steep surface gradients (60% of Japan's area has gradients greater than 15°) the intensive drift process obstructs the development of mature soil profiles. Soils formed under dissected relief conditions are included by the author in the mountain soil group. These mountain soils have not been further subdivided either in the book or on the soil map. Such a view by the author leads to a one-sided concept of the effect of topography on soil formation and to the actual denial of topography as a redistribution factor of temperature and precipitation, and the creation of a vertical bioclimatic zone followed by a soil zone on the earth's surface. This is an unfortunate general shortcoming of the book and of the attached map.

A large part of Japan's territory is colored on the map in solid yellow which designates mountain soil groups. The effect of a vertical soil zone must inevitably be seen in the mountains of Japan where a variation in absolute local elevations from 200m-3,000m occurs. At the same time, the total spread of the Japanese Islands is about 15° (30°-45° North Latitude). The case of the absence of a vertical zone is all the more perplexing, because on level strips the author marks off a clear latitudinal soil zone.

Examining the effect of soil-forming parent material on soil formation the author considers that it develops in the transfer to soils of properties characteristic of the parent material. Thus, according to latest data obtained from geological studies, two-thirds of the parent materials of Japan are associated with the Cenozoic era and a younger age. This predetermines the composition of the soil-forming parent materials over large areas. The author also feels that particular attention should be paid to volcanic ashes as an original and peculiar soil-forming parent material.

Examining the problem of the effect of the human factor on soil formation, the author points out that this effect evolves as a result of irrigation, drainage, terracing, and other agrotechnical measures. In Japan there are six million hectares of agricultural land (or 14% of the total area) of which half is under rice crop. Therefore, the problems of irrigation and terracing and other measures (as an action factor on soils and their transformation) are of great importance.

The author even points out that under influence of the human factor a transition from one soil group to another is possible. This viewpoint concerning the effect of the agricultural activity of the human being on soils is also being analyzed by the soil scientists of the Soviet Union.

Chapters II, IV, and V are devoted to a review of soil cartographic surveys in Japan. Of particular note are the soil studies following World War II.

From 1886-1935 the agrogeological concept prevailed in the soil science of Japan. According to this concept soils were subdivided into groups according to the character of petrographic composition of soil-forming parent materials, their texture, humus content, and gravel. Proceeding from this concept, "agrogeological maps" and a general map of the entire country were compiled for all prefectures of Japan. A general map on a scale of 1:500,000 prepared by Dr. Seke, was presented at the Second International Congress of Soil Science. On the legend to the map soils have been subdivided by texture (sandy, clay loams, clays). Also differentiated were the soils with an acid reaction — the peat, red lateritic, and soils found on the most recent volcanic deposits. The lithology and stratigraphy of parent materials on which soils were formed were indicated. The author states that these soils were widely used for solving problems of land utilization and fertilization. A positive argument for agrogeological maps, in the author's opinion, was the fact that these maps enabled us to show the existing relationships between soils and soil-forming parent materials, which is extremely important for Japan. As an argument against agrogeological surveys, the author considers that there is an improper and inadequate regard in soil classification for other soil formation factors besides the geological (for example, moisture conditions).

An attempt to summarize the data thus obtained, based on the latest views, in order to construct a general map of Japan turned out to be impossible. Therefore, in 1926, a proposal was made to unify data under the soil series system adopted in the United States. This system was developed based on the almost ntical properties of specific soil profiles to- ther with a subsequent unification of closely ke series in the soil districts and regions ready on a geographic base). However, the inciple of developing the series had no suc- ss in Japan. The author sees as the reason r this the fact that this method did not conform genetic soil classification. This method was so unsuccessful because of the absence of a iding principle for such a generalization.

In Chapters IV and V a brief review of con- mporary soil studies is given. The author ints out that after World War II repeated soil udies were made based on contemporary (gen- ic) ideas. Both survey (general) and soil udies and surveys conducted for specific rposes were made. As the end result of ork, soil maps were constructed for all the efectures.

Chapter VI, which is the longest, is devoted describing the soil groups of Japan. As the thor himself points out, the soil groups which distinguishes are considered as conforming the interpretation of this term in Europe and, the same time, to "the Great Soil Groups" of e United States. The author points out that r convenience of study soil groups are sub- vided into zonal, azonal and intrazonal. From udying the classification principles for the il groups discussed by the author, we see at he subdivides them according to the pre- minant effect of some one or two soil forma- on factors. Thus, the author considers the nal soil groups as a synonym of the vegeta- ve groups, the azonal soil groups as groups sociated with topography. The intrazonal il groups are associated with the proximity ground waters or to peculiarities of the lith- logy of soil-forming parent materials (vol- nic ashes and Terra-Rossa).

As was already mentioned, the author dis- nguishes three zonal soil groups — the pod- lic, brown forest, and red soils. In addi- on, there are also the transitional groups such s the gray-brown soils, which are a transition- formation between the podzolic and brown ils, and the red-brown soils (between the rown and red soils). The azonal (into groups mountain and colluvial soils) and the intra- nal soils are likewise subdivided.

Given for each group of soils are a typical orphological description of the pH value vater and salt) and data on chemical analyses: an extract of HCl (with a determination of the atio of SiO_2:Al_2O_3); the total content of carbon d nitrogen, the ignition loss and the exchange- le acidity.

One drawback of the book, in our opinion, the small amount of analytical data avail- le. This deals not only with the number of nalyzed profiles but also with the collection of analyses. Lacking are special analyses which would enable us to examine more thoroughly the problems of the soil genesis (an analysis of the group composition of organic matter, total analyses, etc.), and also the more simple analyses, such as particle-size analysis, the analysis of the adsorption complex, etc. (only for certain profiles is there an indication of the ratios of exchangeable Ca and Mg). This lowers the value of the given material and does not enable us essentially to examine the genetic peculiarities of the soil groups distinguished by the author. Let us examine the data on soil groups discussed in the book.

The podzolic group is typical of the northern part of the Japanese Islands. Within this group the author divides into a subgroup the strictly podzolic and rust-colored forest soils (after Stremme's nomenclature). The rust-colored forest soils are developed on sandy deposits with the B horizon a light-reddish brown color (at the expense of the ocherous color of sandy granules). A weak podzolization is typical of all the soils of this group. In the adsorption complex there are more hydrogen than calcium ions. These are acid soils with a water pH value of 3.8-4.9; the exchangeable acidity in the A_1 horizon is 16, in the B horizon 105. The humus horizon is well developed. There is a large quantity of humus in the soils and it penetrates deeply into the soil (ignition loss in the A horizon is 69.5 and in the C horizon 14.4; the total carbon in the A horizon is 33.5 but in the C horizon 2.5). The B horizon is of a brown or grayish-brown color and accumulations of ferric oxide compounds and humus are found in it. The A_2 horizon is about 5 cm thick; it is distinguished by a large exchangeable acidity (63 meq) and by a strong humification (a total carbon of 9.3% and an ignition loss of 9.3%).

From these data we see that the podzolic soils of Japan differ basically, for example, from the podzolic soils of the European part of the USSR by a greater acid reaction, a greater humification and by a lesser podzolization. It is probable that a more thorough comparison of the podzolic soils of Japan with the podzolic soils of other regions will provide us with interesting material for developing the soils' environmental characteristics.

Of great interest is the group of brown forest soils described by the author. This group is subdivided into two species — the brown forest soils (found under forests) and the brown forest "prairie-like" soils. These two species differ, according to the author, in the thickness of the humus horizon (more or less 30 cm) and by the humus content in the horizon. The B horizon is easily traced in these soils. The B horizon is also quite thick, of a brownish color and nutty-blocky structure.

These two species are formed under different geomorphological conditions. The brown forest soils are found on hilly piedmonts, while the brown "prairie-like" soils are found on high river terraces. They are usually formed under deciduous forests, but also, often under meadow vegetation. The author points out that these soils are apparently related to the grass prairie group association which under the conditions found in Japan appears to be sufficiently stable. The brown forest "prairie-like" soils (analytical data given by the author) have a weak acid reaction (a pH value of 5.4-6.1) with a small quantity of exchangeable acidity (2-1 meq).

The amount of total carbon in the A, B, and C horizon is 8.0%, 5.8% and 3.0%, respectively, during ignition loss, which varies from 20.5%-16%. The ratio of $SiO_2:Al_2O_3$ in HCl extract changes in these same horizons from 1.4-1.18.

The brown forest soils of the Soviet Far East and of the Amur Region, according to Yu.A. Liverovskiy and L. P. Rubtsova, are characterized also by a fairly intensive biogenic accumulation. Thus, the humus content in the A horizon is 8%-12% with a rapid decrease in depth. Typical of these soils is a high base saturation, a weak acid reaction (water pH value of 5.8-6.6), and a weak podzolization. An intensive intrasoil weathering leads to the formation of a red-brown and dark-brown compact B horizon. These investigators have noted that similar soils are formed only under good drainage conditions. The gleying features are apparent when drainage conditions in the soils deteriorate. On ancient terraces slowly overcome by forest, soils are formed which incorporate the features of the brown earth (burozem) and meadow processes. Under a stable formation soils are formed from grass vegetation which these investigators distinguish as brown forest residual meadow soils. A very thick humus horizon and a higher humus content are typical of these soils.

The brown forest soils of Japan found under forest and also the brown "prairie-like" soils are obviously close in their properties to the transitional group of soils described, which is typical of the regions bordering Japan from the west. However, this problem still requires additional study based on a greater amount of data.

It should be mentioned again that the high humus content in the zonal soil groups of Japan (the podzolic, brown forest, and brown "prairie-like" soils) may also be attributed somewhat to the unique nature of the soil-forming parent materials in Japan. This peculiarity lies in the fact that on the surface of most soils there is a layer of fresh volcanic ash of unlike age. This ash, in weathering, has an effect on the fixation of humus in the soils, and on the enrichment of these soils with bases and sesquioxide

Of theoretical interest is the group of gray-brown soils distinguished by the author as a transitional group between the podzol and brow forest soils. A weak acid reaction is associated with them (a water extract pH value of 5.5-5.4 and a salt extract pH value of 4.3-4.0) with the quantity of exchangeable acidity greater than in the brown soils but less than in the podzolic soils. Judging by the ratio of $SiO_2:Al_2O_3$, podzolization in these soils appear weaker than in the podzolic soils, corresponding by horizons to 1.9, 1.5, 1.7, 2.2. The humus in these soils is less stable than in the brown forest soils, and the B gley horizon is of a lighter color than seen in the brown forest soils.

Turning now to a study of the red soils of Japan, the author considers these to have been formed on the products of ancient laterization. The red and red-brown soils are representativ of the soils of this group typical of southern Japan. The A horizon of red soils is not very thick when there is a small amount of total carbon in it. The B horizon has a yellowish-red color and often contains ferruginous inclusions. The soil reaction by profile is acid (the exchangeable acidity is 52-137 meq), the water extract pH value is 4.4-4.9 while the sal extract pH value is 3.8-4.0 when strongly unsaturated by bases. These soils, according to the author, are zonal formations. He consider the red-brown soils as transitional soils from red to brown. Morphologically, these soils differ from the red soils by a brownish or brownish-red color in the B horizon. These soils also have an acid reaction and a low humu content.

The azonal soil groups cover a large part of Japan. Typical of these soils are the intensive drift or removal of soil-forming material and, as a result, an incomplete or partial development of the soil profile. However, whenever there is a weaker drift, the soil profile approaches the zonal group — usually the brown forest soils. In this same soil group are considered the colluvial-alluvial soils, which are subdivided by their humus content into light and dark soils.

Much attention has been paid to describing and studying the intrazonal group of soil groups This is understandable, because the areas covered by these soils are used for rice crops. Among these soils is differentiated a humid soil group and a soil group formed on parent material (after Stremme). The humid soils are examined in greater detail for reasons given previously.

The humid soil groups are subdivided by basic factors which determine their formation. The author considers ground waters as such.

r effect on the soil-forming parent mater-
nay be different and leads to the formation
ur genetic horizons: dark-brown peat,
k humic, rust-spotted, and a dark blue
horizon. Based on the presence in the
s of one or another horizon (or a combina-
of them) the author determines the drain-
conditions under which one or another soil
been formed. As we can see, soils are
livided by the nature of the accumulation
organic matter decomposition process
by the character of the gleying phenomenon.
in this soil group are distinguished the bog,
-bog and also the meadow, gray, and brown
s of lower sections of slopes.

The author presents a schematic map which
oles us to understand the relationship of
different types in this group to topographic
ditions, ground-water level and vegetation
ditions and to zonal soil groups. The same
lytical indices are given for them.

n the author's opinion, the properties of
s developed are determined by the proper-
of soil-forming parent materials inherited
hem. Terra-Rossa (adapted to areas of
estone development) and young volcanic
es are such soil-forming parent materials
in Japan. Terra-Rossa soils have an undiff
entiated soil profile of a reddish color and co
tain a certain amount of crushed stone or rubb .
The young volcanic ashes also have an undifferentiated profile and are enriched with bases.

The book concludes with a short section devoted to general recommendations for increasing the productive capacity of these soil groups.

On the whole, the study by Iiutaka Kamoshita is of great interest. In the book the basic soil groups of the level areas of Japan are examined for the first time, from the standpoint of genetic soil science.

The foregoing data enables us to examine principally the properties of these soils and to arrive at developing specific characteristics defined by the geographic position of Japan and by the history of its surface growth. Of great theoretical interest are the transitional soil groups — the gray-brown and reddish-brown soils which have been distinguished by the author, but which, unfortunately, have been described in too brief a fashion.

Reviewed by A. A. Yerokhina

CHRONICLE

WORK OF THE SOIL PHYSICS SECTION OF THE FIRST DELEGATE ASSEMBLY OF THE ALL-UNION SOCIETY OF SOIL SCIENTISTS

V. N. DIMO

The Soil Physics Section met from May 14-16, 1958, and held six sessions, where 37 papers were heard and discussed. Three of these were papers by scholars from the countries of the Peoples' Democracies.

The sessions were attended by 80-150 delegates of the Assembly of the All-Union Society of Soil Scientists (VOP) and other participants.

The chairman, Professor A. A. Rode, opened the session of the Section. Rode discussed the activity of the first VOP Commission since its organization in December 1956. The principal categories of work of the Commission were:

1. Hearing and discussing papers on soil physics and hydrology.

2. Work on a soil-physics glossary, which was to be a preparatory stage in the compilation of an encyclopedic dictionary. Active members of the VOP from all republic branches were brought into this work, and it was finished.

3. Preparation for the First Delegate Assembly of Soil Scientists.

Professor Rode remarked that organization of the work of the Soil Physics Section was not provided for in the program of the First Delegate Assembly of Soil Scientists. The Soil Physics Section was organized on the basis of a resolution of the Leningrad Conference on Agricultural Soil Physics, meeting under the auspices of the Agricultural Physics Institute of the All-Union Lenin Agricultural Academy (VASKhNIL).

In a paper by Ye. G. Petrov (All-Union Scientific Research Institute of Hydrology and Meteorology [VNIIGiM]), which was devoted to the problem of preventing drought, the utilization of meltwater runoff by adding moisture into the soil by estuary irrigation, and by regular irrigation from ponds, were discussed.

E. N. Blagoveshchenskiy (Academy of Sciences, Tadzhik SSR) discussed the daily v iation of moisture in desert soils and the pr lem of condensation. On the basis of exper mental data the speaker suggested that the water uptake by vegetation in arid regions during the rainless period is chiefly throug increased soil moisture during the night ho He calculates that the moisture added by co densation may amount to some 1000 mm per season.

D. I. Burov (Kuybyshev Agricultural Inst emphasized the importance of agricultural p tices to conserve moisture in the chernozem soils of the Trans-Volga region as a means improving the physical properties of agricul tural soils.

M. M. Abramova and A. F. Bol'shakov (D chayev Soil Institute, Academy of Sciences, USSR) gave a paper on the hydrological role bare fallow in agriculture, emphasizing the portance of the non-productive loss of moist to evaporation from bare fallow under semi-desert conditions. The authors evaluated po tively the role of cultivation at the beginning the growing season. Later on cultivation is negligible importance in reducing the moistu loss. At the same time, cultivation facilitat the more complete utilization of autumn prec tation. From the hydrological point of view they came to the conclusion that bare fallow could be put to use profitably.

P. S. Denisov (Siberian Institute of Agricu ture) discussed the various tillage technique for accumulating and conserving soil moistur in the Kulunda steppe. He pointed out that de plowing of fallow land without a moldboard (4 50 cm), where the ground water is deep, lea to the severe drying of the soil and decrease the yields in the steppe and southern forest-steppe regions of Siberia, in particular in the Kulunda and Omsk steppes.

E. Ewald (Institute of Forestry and Local ent, Eberswald, German Democratic ic) presented the results of detailed studies, particularly on the water re- f sandy soils and layer soil, sandy clay under forest plantations in the region of vald. Especially interesting were the of the root systems. The moisture vas conducted using a combination of ctrical conductivity method and the ry method of drying. Adding sodium le at the surface permitted determina- the nature of the moisture loss in the Using the "Pressure membrane apparat- e wilting moisture for pine seedlings was ained. The values obtained exceeded tscherlich hygroscopicity by 1.5-2.5

. Felitsiant (Institute of Soil Science, my of Sciences, Uzbek SSR) presented sults of laboratory investigations of the and rate of moisture movement in layered The current opinion that stratified soils apillary properties inferior to those of eneous soils was not supported by the ments of Felitsiant. Several new char- stics of the capillary movement of mois- n layered soils were revealed.

G. Gayel' (Chair of Physics and Soil Mel- on, Biology and Soils Faculty, Moscow University) dwelt on the importance of the e and water capacity of sands when for- He came to the conclusion that in forests p sands with a low water capacity, the ds of moisture accumulation by means of retention and bare fallow are not effective. nds with high moisture capacity, all mea- involving both the accumulation and the mical use of moisture are advisable, the so, the higher is the moisture capacity.

M. Alpat'yev (All-Union Institute of Plant re) pointed out that the amount of non- ive precipitation (not used by the plants) ases in accordance with the natural zones unction of the conditions of soil moisture, er, and type of agricultural crop. In each there is a layer of low biological activity soil surface. He suggests a number of ures designed to conserve soil moisture.

N. Michurin (VASKhNIL) devoted his to a description of certain types of soil ure and its capacity to transpiration. On asis of an analysis of transpiration curves me to the conclusion that soil moisture in terval between field moisture capacity and ilting moisture is lost by transpiration in rtion to the moisture deficit of the air, available moisture content amounts to than half the field moisture capacity. the amount of available moisture remains the field moisture capacity, the rate of piration is slowed down and follows a r law.

The paper by O. G. Grammatikata (VNIIGiM) was devoted to the question of the water use from the deep soil layers by plants, in situations where moisture was added and irrigation was practiced. He emphasized the point that, in the calculation of total water use in agricultural situations, it is necessary to consider the entire zone invaded by the roots. This may reach a depth of 2 or even 3 meters where water is added.

S. G. Konurov (Stalingrad Agricultural Institute) investigated the moisture dynamics of light chestnut soils in Stalingrad region, which were sowed to perennial grasses and to spring wheat with various preceding crops. He confirmed the thesis that grasses are undesirable as a preceding crop, since they dry out the soil.

A. F. Vadyunina (Chair of Physics and Soil Melioration, Biological and Soils Faculty, Moscow State University) dwelt on the problem of changes in the hydrophysical properties of solonetzes of the light chestnut subzone with complex melioration and noted that melioration of solonetz soils is especially effective under the combined influence of gypsum and the growth of shrubs. Soil desalinization takes place under shrubs.

L. O. Karpachevskiy (Altay Agricultural Institute) discussed indicators of the hydrophysical properties of certain soils suitable for cultivation in Altay subdistrict. He stressed their importance and the necessity of study in order to evaluate the water regime and the agricultural production possibilities.

K. N. Shishkov (VNIIGiM) discussed the basic situation regarding the problem of the origin of bogs and water-logged soils and their agricultural evaluation. He considered the possible changes in the hydrophysical properties of soil and soil materials where drainage occurs under the conditions of the Meshcherskaya depression.

S. A. Vladychenskiy (Chair of Physics and Soil Melioration, Biological and Soils Faculty, Moscow State University) presented a paper dealing with the question of warming in the vicinity of reservoirs and the control thereof. On the basis of a large amount of data collected by the Department in studies of the effect of the Rybinsk, Ivanovo, and Istra reservoirs on the soils and soil materials of the surrounding territories, the author gave a number of practical recommendations designed to prevent the negative effect of reservoirs.

The second day of the sessions, devoted to soil structure and cultivation, opened with the paper of N. A. Kachinskiy (Chair of Soil Physics and Melioration, Biology and Soils Faculty, Moscow State University) entitled, "Particle-size analysis of soils and their textural classification." He emphasized the urgent need for uniform methods of particle-size analysis. Kachinskiy proposed a new, accurate classification for the particle elements of soils and a textural classification of soils. He also suggested a site-quality scale for soils according to texture, applicable to the various soil zones of the European USSR.

The paper by V. Novak and V. Zvanoveca (Czechoslovakia) was devoted to the method of determining aggregation of soils. Principal attention was given to the effect on results of the method of wetting the aggregates in preparing them for structural analysis. The advantage of preliminary wetting of the aggregates in water for 24 hours by Novak's method was shown. The results obtained by wetting the samples for a day, according to the authors, gave the highest content of water-stable aggregates.

I. B. Revut and I. Kochurova (VASKhNIL) showed that, to improve the fertility of the subplow layer in sod-podzolic soils, it is necessary to till it thoroughly and reduce it to a fine-cloddy and granular state. The addition of high-molecular resins (copolymers of methacrylamide and metacrylic acid) at a rate of 0.04% by weight to the soil gives it a better structure, improves the water regime, and increases the yields.

M. M. Godlin (Ukraine Agricultural Academy) proposed using Nefedov's method (trituration) for preparing the soil for particle analysis to obtained effective but not altered quantities of physical clay in soils. He proposes the introduction of a "coefficient of saturation of physical clay in the soil with humus" (amount of humus per unit amount of physical clay), and on the basis of this coefficient offers a new textural classification of soils.

A. A. Pchelin (Voronezh Forest Engineering Institute), with reference to the chernozems of Central Asia, showed that the water-stability of the structural aggregates depends on their make-up. Friable aggregates are more water-stable than compact ones. He emphasized the role of group I microaggregates in the creation of the water-stable structure of the thick chernozems of the middle Don. Erosion of soils leads to a deterioration in their structure, and control of this requires restoration of the structure with properly selected agricultural practices.

A. V. Koloskova and R. Kh. Akberdina (Kazan Branch of the VOP), from a study of the qualitative composition of the aggregates of several soils of the Volga-Kama forest-steppe, showed that aggregates of different size have different qualitative compositions. The smaller aggregates (<0.25 mm in diameter) have higher chemical qualitative indexes (R_2O_3, humus, etc.). They are of the opinion that the clay content of aggregates is related inversely to their size.

The paper by N. N. Nikol'skiy (Timiryaze Agricultural Academy [TSKhA]) was concer with the constitution and water-stable struct of the soil under various land uses. Attenti was given principally to differences in the a gate structure of virgin and cultivated chern zems and sod-podzolic soils and their relati to changes in water-permeability.

Shan Chih-ney (Chinese People's Republi discussed in detail the problem of increasin soil fertility by drying. Drying leads to a sl increase in the amount of ammonium nitroge so that this process may be partially substit for the application of nitrogen fertilizers to fields. The altered moisture regime is acc panied by a change in the oxidation-reductio conditions.

I. V. Utey (Chair of Soil Science, Kazan Agricultural Institute) presented the results four years' experiments of the PCh-2Ya-35 t layer plow under conditions of productive use in which positive results were obtained even the forest-steppe soils of the Tatar ASSR. T speaker also recommends use of the plow for the radical alteration of solonetzes and solon etz-like soils.

G. S. Smorodin (Bashkir Agricultural Institute), on the basis of a study of the physical properties of the soil, found the most advanta ous method of handling the leached chernozem of the Predural'ye to be a combination of tillage with and without the moldboard and tillag to different depths, varying the depth from 15-16 to 30-35 cm in fields with rotation of crops.

V. I. Bobchenko (VNIIGiM) showed the advantage of using mole drains in the forest-steppe zone. In the steppe zone mole drains in combination with flooding increase the yiel of agricultural crops. In order to increase th stability of mole drains, the authors recommended a new technological means from the field of foundation-laying: drilling the mole drains while preserving the natural soil structure in their walls.

The third day of the sessions of the Section began with the paper by N. P. Poyasov (VASK NIL), "Determining the coefficient of diffusio for CO_2 in the soil." The diffusion of CO_2 was determined by the decreased concentration of the gas in a container on which a sample of soil was placed (AFI method). The principal conclusion from the experiment was the fact that diffusion should be evaluated as the basic factor in gas exchange, providing for normal aeration of those soils that have enough moisture and are not too compact.

On the basis of experimental data, V. N. Di chayev Soil Institute, Academy of Sciences, showed that heat transfer in soils and the pal mineral soils is a function of moisture pends to an important extent on the de- f compaction, dispersion, and content of c material. She considered the mechan- heat exchange in various soil-moisture ions and extablished for a genetic series est-steppe and podzolic soils an increase value of the coefficient of heat diffusivity the first to the second.

I. Gupalo (Odessa Agricultural Institute) ssed the relation between heat and mois- onditions in the soil. Beginning with Kolyasev's theory of differential mois- the author set forth a number of relation- between moisture, compaction, and al properties for disturbed samples. He d that heat diffusivity, which determines arming of the soil at depth, increases as oisture reaches a value retarding plant h. When moisture exceeds the plant- h retardation value, warming slows down, the heat conductivity drops off with fur- ncrease in moisture.

. A. Dmitriyev (Chair of Soil Physics and ration, Biology and Soils Faculty, Moscow University) investigated the thermal ca- of soils from the geochemical point of and found that the specific thermal capa- f soils and loose parent materials is r than that of igneous rocks, since the esses of weathering and soil-formation to the enrichment of the solid phase of and soil materials in chemically bound r and organic matter.

Ye. Kolyasev and A. G. Kholodov (VASKh- recommended the use of hydrophobic earth, is made from any soil by mixing it with ions of surface-active substances (dissolved of organic acids) and aqueous solutions of alts of bi- and tri- valent cations, as hydro- no-electric insulation in the building of us agricultural structures.

. V. Preobrazhenskaya (VNIIGiM) pre- d the results of testing of the gamma-ray od of determining the soil moisture con- under conditions of irrigated cotton in the ta-Aral sovkhoz on medium clay loam, ly saline, light sierozems. For the whole profile, with the exception of the upper 10- ayer, there was good agreement with data the thermostatic method of drying. The od permits the accurate estimation of the r regime of an irrigated field. The lack reement between comparative determina- of soil moisture in the upper 0-10-cm r is explained by the compaction of the latter result of flooding.

he theoretical basis of the use of gamma ation for the absolute measurement of the bulk density of soil was presented in the paper by B. A. Yemel'yanov and R. Ye. Nesterov (VNIIGiM). In order to eliminate the effect of scattered radiation, which interferes with the work, it was suggested that a scintillation counter be used as detector and that an amplitude discriminator be employed. Laboratory tests gave positive results.

I. A. Tyutyunov (Institute of Permafrost Studies, Academy of Sciences, USSR) set forth new, original propositions on the question of the interaction of the mineral portion of the soil with water. He is of the opinion that the heat of wetting is the residual heat of hydration of the ions forming the surface of the solid particles and not the heat of crystallization of water on the surface. The distribution of water over the surface of the mineral particles is determined by the difference in the chemical potentials of the surface of the mineral particles and water. The latter also determines capillary rise.

On the basis of experimental data, Z. A. Nersesova (Institute of Permafrost Studies, Academy of Sciences, USSR) showed that the value of the heat of wetting of clays, with a different content of exchangeable cations, depends on the active surface area and energy of hydration of the exchangeable cations. As the temperature decreases, the surface energy increases, and this is expressed in an increased heat of wetting.

At this point the morning session of the third day of the Soil Physics Section ended.

The work of the Section was characterized by the lively discussions and the large number of questions asked of the speakers. This was evidence of the active interest in the work of the Soil Physics Section on the part of the participants in the First Delegate Assembly of Soil Scientists. Most interest was shown in the paper by N. A. Kachinskiy on soil textures and in the discussion of the paper by M. M. Abramova and A. F. Bol'shakov on the hydrological role of bare fallow under semidesert conditions.

The evening session was devoted to the discussion and adoption of the resolution, wherein mention was made of successful completion of numerous investigations in soil physics in the USSR directed toward the solution of theoretical and practical problems of importance to the people's economy.

At the same time it was pointed out that the present situation regarding soil physics studies is inadequate to the needs presented by our rapidly developing agriculture. The Section feels that primary attention should be given to the development of combined studies in the area of aeration and thermal properties of the soil, and also in the field of soil mechanics and technology. More detailed investigation is required of the nature of structure formation and a number of theoretical questions concerning the water regime of soils, which are of great practical importance.

The Section considers it necessary in the immediate future:

a) to work out a uniform method for large-scale determinations of the soil texture and a single textural classification;

b) to conduct investigations on questions concerning the structure and microstructure of soils, and also on the application of synthetic structure formers;

c) to investigate the physical properties of layered soil materials.

The Section mentioned with satisfaction the application of new methods of investigation in soil physics (semiconductors, radioactive isotopes, etc.) and considers it necessary to strengthen these studies in accordance with modern progress in physics.

It is of the utmost importance to organize a network of soil stations in the various soil zones of the USSR for the large-scale systematic investigation of the moisture, thermal, and aeration regimes of the soils in relation to their properties and to work out methods of controlling these regimes. The resolution mentioned the necessity of assembling textbooks, school equipment, and broad basic monograph works in the field of soil physics. The Sectio welcomes the organization of effort to compile an encyclopedic dictionary of soil physics.

The Section mentions with satisfaction the broadening of scientific relations in the field of soil physics with foreign countries. System atic publication of translations of the most val able foreign works on soil physics is desirabl

The Section considers it extremely necessa to strive in every way for rapid organization o the production of instruments and equipment fo soil physics in the USSR.

The Section also considers it necessary to call periodic specialized meetings on individua questions in soil physics, in particular those that are poorly developed and little-discussed.

After the adoption of the resolution an additional communication by P. U. Bakhtin was heard dealing with the physico-mechanical indexes of soils during treatment.

In closing the session of the Soil Physics Section of the First Delegate Assembly of Soil Scientists, the second chairman of the Section, Prof. N. A. Kachinskiy mentioned with satisfaction the harmonious work of the Section, the wide exchange of opinions, and the good results of personal contact, and expressed the wish that such meetings of workers in the various fields of soil physics will also be repeated in the future.

PORT ON THE WORK OF THE MARI BRANCH F THE ALL-UNION SOCIETY OF SOIL SCIENTISTS IN 1958

. VOROZHTSOVA-ORLOVA

The Mari Branch of the All-Union Society of l Scientists was organized on November 30, 6. The total membership was 40 persons on uary 1, 1958. On January 1, 1959, the mbership was 39.

The general membership of the Mari Branch constituted on November 1, 1959, was com- sed as follows: 6 soil scientists; 13 fores- s; 12 agronomists; 4 chemists; and 4 miscel- neous workers. At institutions of higher learn- (Volga Regional Forestry Institute and the ri Pedagogical Institute), there are 20 work- s; 16 at institutions of the Republic; and 3 in oduction personnel.

In 1958 two general meetings of members of e Society were held with the participation of embers of the students' scientific society on il science at the Volga Regional Forestry In- itute.

The first meeting was devoted to the reading a report on the activity of the Mari Branch the Society in 1957, with the joint report of e revisionary committee and the selection of legates from the Mari Branch of the VOP to e First All-Union Delegate Assembly.

The minutes were approved by the entire ssembled membership, which extended the thority of the Mari Branch Presidium for other year. The second general meeting as held in December 1958. It was devoted tasks of the Mari Branch of the VOP in ght of the December Plenum resolution of e Central Committee of the Communist arty of the Soviet Union (paper by V. N. mirnov), and to a short discussion of work f the First Delegate Assembly of Soil cientists (an account by the delegation). The eeting presented to our soil scientists the roblem of preparatory work required for ompilation of a new, more detailed soil ap of the Mari ASSR, which will show the oil resources of the Republic. The meet- ng entrusted this work to a group of soil cientists from the Volga Regional Forestry Institute and the Soils Branch of the Ministry of Agriculture of the Mari ASSR.

The kolkhoz land-utilization soil survey of the Mari ASSR will be finished in 1960. A group of Mari soil scientists has been given the task of preparing a detailed summary of the genesis and a systematic list of soils of the Mari ASSR. The meeting considered that it was necessary to pursue the compilation of a systematic map of the soil-forming parent materials of the Mari ASSR, to improve the soil studies of kolkhoz lands, and to intensify efforts to work out methods for increasing the fertility of farm and forest soils.

Members of the Mari Branch of the VOP (M. D. Danilov, V. N. Smirnov, E. V. Gur'yev, P. N. Grachev, L. P. Samsonova, A. D. Turgenev, L. G. Trukhan, and others) took part in the discussion and elaboration of means to improve agricultural knowledge. The majority of members of the Branch became members of the special committee set up for this purpose under the Council of Ministers of the Mari ASSR.

During the report year a very important part of the work of the Mari Branch was the scientific assistance given to the Soils Branch of the Land Development Division of the Ministry of Agriculture of the Mari ASSR in the compilation of soil maps for the kolkhozes of the Mari ASSR.

This assistance included both scientific consultation, the organization of a seminar of soil scientists prior to field work, review of diaries and maps and several reports, and review of the data obtained (V. N. Smirnov). In addition, the Agricultural Chemistry Laboratory of the Mari Agricultural Experiment Station rendered assistance to the Soils Branch of the Ministry of Agriculture of the Mari ASSR.

In the 1958 field season V. N. Smirnov repeatedly went out to the field to render scientific assistance and consultation service to soil scientists of the Land Development Division and the Soils Branch.

In relation to scientific assistance to kolkhozes production in growing the bumper crop of corn, the Agricultural Chemistry Laboratory of the Mari Agricultural Experiment Station (A. G. Trukhan and V. A. Usynina) furnished chemical analyses of 300 soil samples from cornfields. To kolkhozes of the Republic this Laboratory provided analyses of local fertilizers: 66 samples of peat and 11 samples of limestones.

Of great importance to forest management of the Mari ASSR was the study of forest soils of plantations and tree nurseries. In this aspect of the work, members of the Mari Branch (V. N. Smirnov, G. K. Nezabudkin, and N. O. Murav'yeva) compiled schedules for the use of fertilizers in tree nurseries of forestry collectives, and in seed tracts and distributed them to the forest khozes for practical use.

To furnish scientific assistance to the forest khozes in the reforestation of cut-over and burned-over areas, members of the Society (V. N. Smirnov, G. K. Nezabudkin, S. I. Rozhnov, and N. O. Murav'yeva) visited the Volga, Mushmarinskiy, and Kokshayskiy forest khozes; and as a result recommendations were made for forest khozes regarding the reforestation of burned-over and cut-over areas. S. I. Rozhnov designed a plow-planter and forest cultivator, which is now being used experimentally in several forest khozes under production conditions.

Students in forestry and forest soil science societies undertook experiments with fertilizers in tree nurseries and forests and also studied the soils of pine-foxberry, mixed spruce, broadleaf, and broadleaf-coniferous forests. They also investigated the effect of adding marl to the podzolic sandy soils of tree nurseries and the influence of tree and shrub species on the properties of forest soils.

In the practical application of information on soils in agriculture much work was done by soil scientists in the Land Development Division. Kolkhoz land-use soil maps were handed over to the kolkhozes of three administrative regions. In addition, soil analyses were made for kolkhozes of other regions, for which s maps and soil characteristics are being com piled.

Scientific assistance was rendered to me bers of the Mari Branch in the form of scie tific consultation on dissertations. Editing also provided for scientific articles and boo written by members of the VOP Branch on s science, silviculture, forest crops, and agr omy (assistance by Nezabudkin, Zudnin, an Danilova).

In the year of report, members of the Mari Branch published a large number of scientific cles on soil science, botany, silviculture, and forest crops. Serious attention was given to di seminating scientific information by means of lectures broadcast on the radio and published i the local newspapers Mariyskaya Pravda [Ma Truth] and Mariy Kommuna [Mari Commune].

M. D. Danilov delivered a lecture to the people of the city of Yoshkar-Ola on strengtl ening the ties between school and everyday l and on the further development of the system of popular education in the country. V. N. Smirnov delivered ten lectures on the soils c Mari ASSR, on its individual regions and on the fertilization of forest soils. G. K. Nezabudkin, A. R. Chistyakov-Rozhnov, P. N. Grachey, L. P. Samsonov, A. L. Turgenev, Ye. V. Gur'yev, and L. G. Turkhan delivered 23 lectures on soils and other current proble of agriculture. In addition, a number of our colleagues made radio broadcasts and published articles in local newspapers.

Summarizing the report on activity of the Mari Branch of the All-Union Society of Soil Scientists for 1958, we may say that our Branch of the Society during the year of the report did a significant amount of work in spreading scientific information, and also rendered assistance to the Soils Branch of th Land Development Division of the Ministry of Agriculture of the Mari ASSR, provided cons tation service on soil science, agronomy, sil viculture, and forest crops. At the same tim the work of the Branch showed deficiencies, such as the small number of general meetings Special attention will be given to this in the coming year.

IMPORTANCE OF THE SCIENTIFIC WORK S.S. YARUSOV (1901-1953)

Askinazi

ve years have passed since the death of y Sergeyevich Yarusov, Doctor of Agri- al Sciences.

ter completion of his studies at the TSKhA ryazev Agricultural Academy), S. S. Yaru- egan his duties as a practical worker in at the Plant Nutrition Station of the Chair lividual Farming of the TSKhA, which nder the direction of D. N. Pryanishnikov. ey Sergeyevich entered the laboratory to on his own subject of interest, the funda- al reclamation of acid sod-podzolic soils ning them.

orking in the laboratory of D. N. Pryanish- , S. S. Yarusov distinguished himself as y diligent and resourceful agronomist, who ed very hard to increase his competence ad a broad mastery of the literature of ubject on which he was working. Upon letion of his internship in the laboratory N. Pryanishnikov in 1933, he was trans- ed (in accordance with assignment policy for ialists) to work in the Agricultural Soils tute, and then to the Lime Group of the (All-Union Fertilizers and Soil Study In- te). At the latter institution he worked ersonally experimented for 20 years, ally until the end of his life.

ergey Sergeyevich both successfully and fully conducted field and pot experiments, lementing them with carefully conducted ratory investigations, completing with his hands numerous analyses of soils and ts and model experiments of a chemical, icochemical, or agronomic nature. With iderable success he compiled literature ews on problems concerning the effective- of fertilizers (10, 11, 14).

the list of papers of Sergey Sergeyevich usov (about 75) the large majority deal soil liming. Without exaggeration we may that no one accumulated as much original rimental data on the liming of soils as did ey Sergeyevich in the 30 years he devoted to the task. Let us dwell briefly on some of them.

Yarusov studied quite actively the nature of soil acidity. He understood well that a knowledge of the nature of soil acidity was very important for explaining the reasons for its harmful effects on plants and he worked out means of eliminating it. In the laboratory of D. N. Pryanishnikov he devised a method of determining the soil acidity from its readiness to react directly with $CaCO_3$ (1). He also suggested an improved method on a large scale for the determination of hydrolytic acidity — from the pH in a sodium acetate extract (3). He established experimentally the comparatively harmful effects of H^+ and Al^{+++} on plants (15) and also the ability of soils with high concentrations of H^+ and Al^{+++} to break down and dissolve $CaCO_3$ and phosphorite.

Yarusov also devised other original laboratory methods and procedures for the direct determination of H^+ and Al^{+++} in the salt extract of acid sod-podzolic soils and krasnozems (treatment of the soils with barite). He approached the problem of the nature of soil acidity from all aspects. At the same time he did not overlook the appearance and "judgement of the whole plant." His investigations on problems of soil acidity constitute a very great contribution to soil and agronomic science. Yarusov paid particular attention in his investigations to the solution of the problem of the fundamental improvement of acid soils by the use of lime (2, 8). He obtained experimental data on the effect of lime on the reaction of soil, on the value of the exchange capacity of acid soils, on the concentration of exchangeable bases, etc. For this purpose he worked out a method of determining exchangeable Ca in limed soils (7). We should mention that there is no other such method in the literature (there exist methods for carbonate soils, but not for limed soils). Unfortunately the results of this methodological work are ignored by many investigators, and this is a source of error.

The problem of the composition of exchangeable bases in the soil is closely related to another: the mobility and availability of adsorbed bases to plants in various soils depends on their properties (on the composition of the minerals composing them, on the content of organic material, etc.). A large amount of original data and data from the literature on this subject collected by Yarusov were used by him in the defense of his doctoral dissertation (5, 13, 15). Unfortunately his dissertation has not been published at all up to the present time.

A number of investigations by Sergey Sergeyevich were devoted to the effects of lime on the nutritional regime of the soil, especially on its phosphate regime. He organized and systematically conducted broad agronomical studies of soils in the field and pot experiments with liming of sod-podzolic soils, as well as chemical analysis of the plants and determination of their utilization of the basic nutrients (2, 4). He studied the same soils for their microbiological and physical properties. To clarify the mechanism of the favorable effect of lime on the phosphate regime of the soil he conducted very precise preliminary experiments on various representative preparations of phosphates (Ca, Fe, Al) of different basicity. A generalization of the results of numerous studies on this subject provided a correct notion of the effect of the prolonged activity of lime fertility (2, 4).

In his investigation Yarusov showed the significance of different rates of lime application (normal, small, micro-applications, etc.) and of application methods with crop rotation (single, split, placement, surface) for soil fertility and increased crop yields (6, 8, 12, 14). The dogmatic approach that has been in favor during recent years in many quarters, involving the stubborn and completely unfounded recommen tion of single applications of lime "for every phase of life," has now been condemned and overthrown not only by the theory of liming but also by the facts of agricultural productio Great recognition in this is due to Yarusov for the numerous studies he made on this problem (12, 13, 14, 15).

We should also call attention to a series of summary works of a general nature on the effectiveness of lime, its activity and sequelae in many experiments in the USSR (10) and broa (11), as well as to generalizing experimental work on the effectiveness and apparent future of liming in the USSR under particular five-year plans. Also reference should be made to articles devoted to establishing the effectiveness of liming and attesting the active part played by their author in planning the widespread use of lime in the agriculture of the USSR, etc. (18, 10).

S. S. Yarusov was one of the leading staff members of the VIUA and devoted much time t the compilation and editing of various texts an handbooks on fertilizers.

Before the Great Patriotic War he was a member of the editorial board of the journal Khimizatsiya Sotsialisticheskogo Zemledeliya (Chemicals in Socialist Farming) for about 10 years. Many authors still remember the grea and useful work of this energetic colleague as scientific editor of the journal.

Yarusov left us a rich scientific inheritance. Many of his works, which should be called classics, have now become bibliographi rarities.

We suggest that the best memorial of Yarusov will be the continuation and extension of his work by the scientific community of agronomists and soil scientists, and also the publication of a volume of the collected works of S. S. Yarusov.

We regret most sincerely the untimely death of so erudite and talented an investigator, a modest scholar, fine analyst, great patriot of the Motherland, who devoted all his strength and knowledge to science.

* * * *

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NIKOLAY PROKOF'YEVICH BELOV (1889-1958)

By a group of colleagues in the Kola Branch, Academy of Sciences, USSR and V. V. Dokuchayev Soil Institute, Academy of Sciences, USSR

On February 25, 1958, the Kola Branch suffered a grievous loss: life ended for one of its oldest workers, soil scientist Nikolay Prokof'yevich Belov, who was everlastingly dedicated to the opening of our North and devoted almost two decades of his life to this goal.

Nikolay Prokof'yevich was born in 1899 in Bezhetsk county of Tver province, now Kalinin region, to a peasant family. After completing the three-year pedagogical courses at Krasnyy Kholm, he worked for three years in a rural school, and in 1922 he entered the Geographical Institute at Leningrad.

Even in his student years Nikolay Prokof'yevich showed an inclination for investigative work. These years were not easy; he had to earn his living, often at hard physical labor. But his morale was always high and he was attentive and considerate toward his companions.

In 1929, after finishing his professional studies, Nikolay Prokof'yevich began work for the V. V. Dokuchayev Soil Institute, Academy of Sciences, USSR and the SOPS (Council for the study of the Production Potential of Russia) also of the Academy. He visited Kara-Kalpakiya, Kazakhstan, Bashkiriya, the Lower Volga, Turkmeniya, Vologda region, the Kulunda steppe, the forests of Arkhangel'sk region, and the Komi ASSR.

The diversity of the areas studied and the variety of tasks undertaken by the expeditions in which he participated perfected Nikolay Prokof'yevich as an investigator.

Nikolay Prokof'yevich went to the North as an experienced scientific worker, well-versed in the problems of the genesis and geography of soils and their evaluation as to productivity. He devoted all his mind and energy to the study of the soils of Murmansk region. He was a tireless and enthusiastic field investigator.

The results of the field studies of Nikolay Prokof'yevich are recorded in the records of the expeditions of the V. V. Dokuchayev Soil Institute and the SOPS of the Academy of Sciences, USSR.

His extensive manuscript notes on the stud of the soils of Murmansk region are preserve in archives of the Kola Branch of the Academ of Sciences, USSR.

He studied the lands from Svyatoy Nos cap to Keyva and beyond to Camp Titan, the basin of Ponoy River, the regions to the west of Murmansk, the areas of Lake Kapustnykh and Kovda, Kandalaksha, Yena, Alakurt', and a number of others. He conducted detailed investigations of the territory of the Botanical Garden to study the genesis of the soils and to elucidate the processes of soil formation. His work in more familiar regions was directed toward the solution of agricultural production problems (along the railroad from Murmansk to Loparskaya Station, in the region of Monchegorsk and Olen' Station, Apatit Station, etc.).

Distant expeditions were undertaken by Nikolay Prokof'yevich under extremely difficult conditions. He traveled on foot by animal paths or simply by compass, often in constant drenching rain, with the minimum convenience of life, and with a knapsack on his shoulders. Under these conditions he spared neither strength nor health in compiling data for a large monograph, which he was not able to complete. In all, Belov wrote and published about 50 scientific works and compiled about 40 soil maps; two were devoted to the whole of Murmansk region.

We shall always cherish the memory of Niko lay Prokof'yevich, as a man deeply dedicated to his work, a fine companion, always ready to give help in whatever way it might be expressed He was extremely modest despite his erudition and deep knowledge.

To us, his friends and colleagues, falls the duty of preserving the rich store of data collected by Nikolay Prokof'yevich and of endeavor ing to complete his unfinished work.

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AIBS Russian Monograph Translations

ıe AIBS is in the process of expanding its Russian Translations Program extensively. Funds to subsidize nslation and publication of important Russian literature in biology have been obtained from the National ience Foundation, as part of a larger program to encourage the exchange of scientific information between e two countries. The following monographs have been published:

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